SILICON CHIP

NOVEMBER 2010
ISSN 1030-2662
PRINT POST APPROVED
- PP255003/01272

$8.95* NZ$11.25 INC GST

It's time to build our new, exceptional performance

DAB+/FM Tuner

ULTRASONIC ANTIFOULING:
Installing the system in your boat

RFID SECURITY SYSTEM
Low cost - universal - reads up to 8 tags

BROADBAND RADAR:
A revolution in small vessel navigation!

PARTY TIME AT JAYCAR

Roadies Cable Tester

Simply plug in the cables under test and turn the rotary switch. The LED array gives an instant go/no-go status of each conductor path in the cable. With tough all-metal construction, its ideally suited for any tradie or roadie working on cables.

- Requires 1 x 9V battery
- Dimensions: 190(L) x 98(W) x 35(H)mm

AA-0405

$59.95

Master Handbook of Acoustics 5th Edition

An essential technical reference source for acoustics. A hands-on approach to acoustic measurement, room dimensions, speaker placement, room response, reverberation and how to build sound absorbers or diffusers.

- Softcover, 510pages, 235 x 190mm

BA-1490

$72.00

UHF Wireless Microphone System

Suitable for schools, churches, karaoke, weddings etc. this dual channel UHF wireless microphone system that is not short on features. This system offers the superior performance and convenience found on more expensive models. Incorporates two microphones with easy to use infrared pairing and wireless transmission up to 100m line of sight.

- Budget non-diversity receiver
- 2 channel
- 2 microphones included
- Requires 4 x AA batteries
- Dimensions: 420(W) x 210(D) x 45(H)mm

AM-4122

$269.00

USB Cassette Deck

Record cassette tracks to a computer via USB or play back through the built-in SW speaker. Can also run the line level outputs to an external amplifier and use it as a component cassette deck.

- Dimensions: 178(L) x 72(H) x 178(W)mm

GE-4054

$79.95

Active 12" 150W Subwoofer

This high-performance powered subwoofer is finished in a timber veneer and houses a 12" driver and amplifier. The amp is rated at 150 watts RMS, has auto power-on, level adjustment, crossover frequency adjustment, phase reversal switch, high and line level inputs as well as high and line level outputs. Line level connectors are gold plated RCA while high levels are via spring loaded clips.

- Frequency response: 20 - 150Hz
- Dimensions: 350 (W) x 440 (H) x 420(D)mm

CS-2457

$239.00

100WRMS 2.1 Active Satellite Speaker-Mixer-Amp Set-up

A complete DJ, karaoke or music sound system in one package, with 12" active sub and a pair of 2 way 8" satellite speakers. Includes a 4 channel mixer that takes inputs from any devise that connects to line level RCA, XLR or 6.5mm inputs. Record to a computer or digital multi-stack recorder via RCA line outputs. Two Speakon 4m cables included.

Power output: Amp 150WRMS, Speakers 100WRMS
Driver: 12" paper cone speaker
Freq. resp: 40HZ - 20kHz
Dimensions:
Amp 410(W) x 320(H) x 460(D)mm
Speakers (ea) 250(W) x 365(H) x 255(D)mm

CS-2545

$949.00

DJ Single Headphone with Handle

Closed back, single cup headphone, designed especially for DJs. Keeps one hand available and frees you up from the constraints of wearing headphones. Curly cord cable terminates to 6.5mm plug.

Driver diameter: 50mm
Impedance: 48 ohms
Sensitivity: 98±3dB
Frequency response: 15Hz - 20kHz

AA-2059 WAS $69.95 Limited Stock

$29.95
SAVE $40.00

5" Indoor/Outdoor Speakers

Versatile speakers that can be mounted to a wall or ceiling and can be rotated 180 degrees for perfect sound projection. Ideal for conference rooms, auditoriums, lecture halls or out on the patio. Please note that CS-2436 sold as a pair; CS-2438 is sold individually.

5" Speakers - Sold as pair
Frequency response: 120Hz - 20kHz
Power handling: 50WRMS
Nominal impedance: 8 ohms
Dimensions: 245(H) x 185(W) x 168(D)mm
CS-2436 $99.95 pair

6.5" Speaker
Frequency response: 50Hz - 22kHz
Power handling: 80WRMS
Nominal impedance: 8 ohms
Dimensions: 296(H) x 217(W) x 190(D)mm
CS-2438 $129.00 each

USB MIDI Interface

Connect any MIDI device to your computer: keyboards, controllers, instruments, sound cards, samplers, drum machines etc. Plug and play, no software or drivers required. MIDI in and MIDI out connectors.

- Cable length 2m

XC-4934

$39.95

30 Electronic Musical Projects

This book has 30 projects to build based around musical instruments. Projects include - metronome x 4, guitar practice, accompaniment drummer, guitar bass booster, treble boost preamp, presence boost, connecting guitar pickups, guitar preamps, practice amp, envelope control, distortion box, waa waa, echo and reverb, tremolo, sustain, phasers, bonger, percussion box, sound generators, organ, etc.

- Softcover. 52 pages 135 x 210mm.

BM-2450

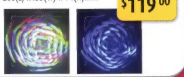
$6.50

Moondot Revolving Disco Light

Liven up any party with this funky light display. Featuring 18 high brightness red, green and blue LEDs that rotate, change colours and direction in response to music being played.

- 10° beam angle
- Auto mode (plug-play effect)
- Sound activated mode
- Mains powered
- Weighs 2kg
- Measures 200(L) x153(W) x 94(H)mm

SL-2898



$119.00

To order call 1800 022 888
www.jaycar.com.au

Prices valid until 23/11/2010. While stocks last. No rainchecks. Savings are based on ORRP.

Jaycar Electronics
Better, More Technical

Contents

Vol.23, No.11; November 2010 www.siliconchip.com.au

SILICON CHIP

Features

12 Broadband Radar: A Quantum Leap Forward
Mariners have always needed to know the quickest and safest route and what obstacles might be encountered on the way. Broadband radar promises to revolutionise marine navigation – by Kevin Poulter

90 Review: Altium Designer & the Nanoboard 3000
Arguably the premier design package in Australia, Altium Designer is software for designing PC boards, circuits, Field Programmable Gate Array (FPGA) projects and embedded software – by Mauro Grassi

Projects To Build

20 Build A Hearing Loop Level Meter
Setting the correct signal level and minimising noise are critical factors when installing a hearing loop. This easy-to-build level meter will allow you to achieve optimum results – by John Clarke

26 Digital Lighting Controller For Christmas Light Shows, Pt.2
This controller will make your Christmas light display the best in your suburb. Here's how to put it together – by Nicholas Vinen & Jim Rowe

44 An RFID Security System
This RFID (radio-frequency identification) system offers high security but is low in cost. Team it with an electric lock and you could have a secure keyless entry system – by Jeff Monegal

70 A High-Quality DAB+/FM Tuner, Pt.2
Second article shows you how to assemble the two PC boards and install them into a low-profile custom steel case – by Mauro Grassi

80 Ultrasonic Anti-Fouling Unit For Boats, Pt.2
Pt.2 has all the details on encapsulating the ultrasonic transducer so that it is safe to handle and will operate reliably, even underwater. We also describe a typical installation in a boat – by Leo Simpson

Special Columns

38 Serviceman's Log
Do-it-yourself servicing at the deep end – by the Serviceman

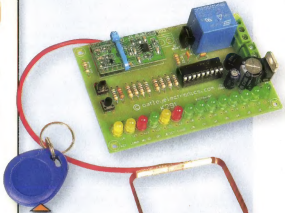
65 Circuit Notebook
(1) Electronic Fuse Employs A Relay; (2) Golf Buggy Battery Charger Control; (3) Reversing Camera Delay; (4) Lullaby & Lamp Timer; (5) High-Performance Shortwave Converter

98 Vintage Radio
Traeger's first pedal radio & other replicas – by Rodney Champness

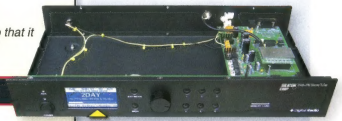
Departments

2 Publisher's Letter
4 Mailbag
43 Order Form
97 Product Showcase
106 Ask Silicon Chip
109 Notes & Errata
110 Market Centre

Build A Hearing Loop Level Meter – Page 20.



An RFID Security System – Page 44.



Building The High-Quality DAB+ & FM Stereo Tuner – Page 70.

Ultrasonic Anti-Fouling: Potting The Transducer & Installing The Unit In A Boat – Page 80.

SILICON CHIP
www.siliconchip.com.au

Publisher & Editor-in-Chief
Leo Simpson, B.Bus., FAICD

Production Manager
Greg Swain, B.Sc. (Hons.)

Technical Editor
John Clarke, B.E.(Elec.)

Technical Staff
Ross Tester
Jim Rowe, B.A., B.Sc
Mauro Grassi, B.Sc. (Hons), Ph.D
Nicholas Vinen

Photography
Ross Tester

Reader Services
Ann Morris

Advertising Enquiries
Glyn Smith
Phone (02) 9939 3295
Mobile 0431 792 293
glyn@siliconchip.com.au

Regular Contributors
Brendan Akhurst
Rodney Champness, VK3UG
Kevin Poulter
Mike Sheriff, B.Sc, VK2YFK
Stan Swan

SILICON CHIP is published 12 times a year by Silicon Chip Publications Pty Ltd. ACN 003 205 490. ABN 49 003 205 490. All material is copyright ©. No part of this publication may be reproduced without the written consent of the publisher.

Printing: Hannanprint, Noble Park, Victoria.

Distribution: Network Distribution Company.

Subscription rates: $94.50 per year in Australia. For overseas rates, see the order form in this issue.

Editorial office:
Unit 1, 234 Harbord Rd,
Brookvale, NSW 2100.

Postal address: PO Box 139,
Collaroy Beach, NSW 2097.

Phone (02) 9939 3295.

Fax (02) 9939 2648.

E-mail: silicon@siliconchip.com.au

ISSN 1030-2662
Recommended and maximum price only.

Publisher's Letter

The NBN is looking more like a white elephant

Every time another report appears on the National Broadband Network it inevitably becomes another piece of evidence in the monumental folly that this project has become. That the Federal Government can still blithely proceed with a project with a projected cost of 43 billion dollars but no cost/benefit analysis seems incredible enough. Then it was announced that the NBN rollout in Tasmania would be strung pole-to-pole rather than underground, repeating the mess that was made years ago with cable TV.

Now, it appears that not enough people in Tasmania are taking up the service as it becomes available. Apparently they either don't need it or it is too expensive, or both. Well, we are not surprised. For most people, present broadband internet services are probably adequate. While just about everyone who logs on and downloads stuff would like it to be faster, they are generally not prepared to pay substantially more to save a small amount of download time.

So what can the government and the NBN authority do to increase the take-up? One proposal is that people might be forced to take it up if they want to keep their existing fixed line phone service. Apart from being a most unwelcome draconian approach, it also ignores what is presently happening out there with fixed-line phone services – people are abandoning them, as they have been for years.

In fact, several of my own relatives have recently abandoned their fixed-line phones, figuring that their mobile phone plans made the fixed line unnecessary. Furthermore, they don't bother with fixed-line internet services either since they have 3G internet as part of their mobile plans. In effect, they are always "on-line" and they like being able to connect at any time, without cables.

When 4G mobile services become available, the move away from fixed line services is likely to become a stampede and it will make the NBN even less viable. Virtually anyone with a mobile phone knows about 3G and knows that much faster 4G services are not far away.

So if the government and the NBN authority think that they can force-feed their potential customers with this service, they are horribly misinformed – as usual!

In any case, part of the deal with the NBN is that the government has decided to pay Telstra a cool 11 billion dollars to transfer its fixed-line customer base to the NBN. No doubt Telstra is anxious to do this as soon as possible – before the customer base deteriorates much more and its revenue continues its inexorable slide.

In fact, Telstra's fixed line revenue is being squeezed on two sides. As noted above, domestic customers are giving up their fixed lines and on the commercial side, more and more businesses are converting to VOIP services, as we recently did in the SILICON CHIP offices. It has more than halved our telephone costs. Multiply that trend in thousands of businesses across Australia and you can see that Telstra has a grim future as far as fixed-line revenue is concerned.

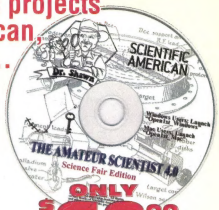
There is little doubt that the whole situation involving the NBN and Telstra is a mess – a government-created mess. Let us hope that the government finally sees reason before the rollout begins in earnest on the mainland. It should abandon the NBN and forget about paying Telstra $11 billion, even though that will massacre Telstra's share price. It should then let Telstra and its competitors get on with providing internet and phone services – and let the cards fall where they may.

Leo Simpson

FANTASTIC GIFT IDEA FOR STUDENTS OF ALL AGES!

THE AMATEUR SCIENTIST

An incredible CD with over 1000 classic projects from the pages of Scientific American, covering every field of science...



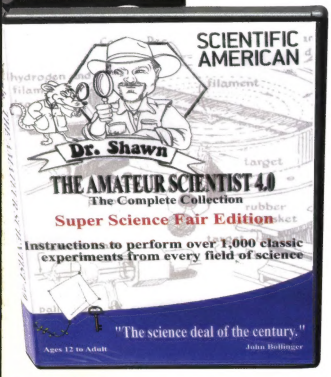
NEW VERSION 4 - JUST RELEASED! GET THE LATEST VERSION NOW!

Arguably THE most IMPORTANT collection of scientific projects ever put together! This is version 4, Super Science Fair Edition from the pages of Scientific American. As well as specific project material, the CDs contain hints and tips by experienced amateur scientists, details on building science apparatus, a large database of chemicals and so much more.

ONLY $62.00

PLUS $10 Pack and Post within Australia

NZ P&P: $AU12.00, Elsewhere: $AU18.00



"A must for every science student, science teacher, science lab . . . or simply for those with an enquiring mind . . ."

Just a tiny selection of the incredible range of projects:

• Build a seismograph to study earthquakes • Make soap bubbles that last for months • Monitor the health of local streams • Preserve biological specimens • Build a carbon dioxide laser • Grow bacteria cultures safely at home • Build a ripple tank to study wave phenomena • Discover how plants grow in low gravity • Do strange experiments with sound • Use a hot wire to study the crystal structure of steel • Extract and purify DNA in your kitchen •Create a laser hologram • Study variable stars like a pro • Investigate vortexes in water • Cultivate slime moulds • Study the flight efficiency of soaring birds • How to make an Electret • Construct fluid lenses • Raise butterflies as experimental animals • Study the physics of spinning tops • Build an apparatus for studying chaotic systems • Detect metals in air, liquids, or solids • Photograph an ant's brain and nervous system • Use magnets to make fluids into solids • Measure the metabolism of an insect . . . • and many, many more (a thousand more, in fact!)

See the V2 review in SILICON CHIP, October 2004. . . or read on line at siliconchip.com.au

This is the ALL-NEW Version 4 . . . it's even BETTER!

HERE'S HOW TO ORDER YOUR COPY:

BY PHONE:* (02) 9939 3295 9-5 Mon-Fri

BY FAX:# (02) 9939 2648 24 Hours 7 Days

BY EMAIL:# silicon@siliconchip.com.au 24 Hours 7 Days

BY PAYPAL:# PayPal silicon@siliconchip.com.au 24 Hours 7 Days

BY MAIL:# PO Box 139, Collaroy NSW 2097

BY INTERNET:^ siliconchip.com.au 24 Hours 7 Days

* Please have your credit card handy! # Don't forget to include your name, address, phone no and credit card details. ^ You will be prompted for required information

There's also a handy order form inside this issue.

Exclusive in Australia to: **SILICON CHIP** siliconchip.com.au

MAILBAG

Letters and emails should contain complete name, address and daytime phone number. Letters to the Editor are submitted on the condition that Silicon Chip Publications Pty Ltd may edit and has the right to reproduce in electronic form and communicate these letters. This also applies to submissions to "Ask SILICON CHIP" and "Circuit Notebook".

Solar power article did not give the whole story

George W. Bush said that the British had information that Saddam Hussein had tried to obtain uranium from Niger. It was true. But what he deceptively didn't say was that the USA's own intelligence agencies had looked at that information and dismissed it as wrong.

And your article in August 2010 about solar thermal power did the same. Everything you said was true but the issue is what it didn't say. It's not a secret what the power generated by that plant in Spain costs.

But that was left out. The only reference to the price of this type of power was that a plant that will open at some time in the future in the US might be able to generate power at 20c/kWh. Which considering that's about what Australians pay for electricity would sound reasonable to an uninformed person. In fact, the price at the gate for the Spanish plant is 27.5 eurocents/kWh or 40c/kWh. Which is over 10 times what the CSIRO's *Heat Is On* report says coal-generated power in Australia costs to produce.

Even 20c/kWh is three times the price of wind-generated power. It's twice what ANY other form of power costs. And no mention of that plant only being able to operate about one day in two. Ten times the price and not able to operate half the time isn't an honest definition of "baseload". According to the CSIRO report, this technology came a very distant last in the race to find what would best replace dirty coal.

It's just delusion to choose the loser as the one to back.

Gordon Drennan,
Burton, SA.

Comment: you make a good point. It is true that the high cost of renewables is seldom discussed by those people who advocate that we must move away from coal-fired power stations.

Modern electronics leaves much to be desired

It's 2010, so why can't they make the following? If we could put a man on the Moon 30 years ago why can't we have:

(1) A microwave oven that remembers the time after loss of power? We live in a caravan, which means that every time we move to another park we have to disconnect the 230VAC power and when we get to our new site, we have to reset the clock on our microwave oven. A microwave oven that targeted the caravan and RV market would need to have small dimensions and low power; under 1000 watts would be ideal. But the main selling feature would be battery backup for the clock and personal memory settings.

Another option for an RV microwave could be a larger clock display and a 12V connection so that the clock display still works when the power is disconnected. This would mean that RV manufacturers could do away with a separate clock.

(2) A video recorder that remembers the time and the timer record data? If modern recorders or PVRs can retain the station set-up, why not retain the time record information and clock data as well, after loss of power?

I remember a National MV300 VCR made in the early 80s had a two Farad capacitor that functioned as the back-up for the clock and recording times. A later model Philips VCR used two AAA batteries for the same thing. That was nearly 30 years ago. Surely the makers of modern recorders could do better today?

We are travelling around Australia and we move from site to site every

Praise for PIC Programmable Ignition

I am an electronics, car and computer enthusiast of many years. I recently retired from the defence force after 26 years as an electronics engineer and I now have time to get back into my old hobbies. I started out reading *Practical Wireless* as a teenager in England and later *Practical Electronics* and *Electronics Today International*. I now read SILICON CHIP regularly and I find it to be very enjoyable.

Now that I can afford a decent CRO and other equipment I am delighted to get back into constructing and repair work. I was particularly pleased to see the Programmable Ignition System Mk.2 (SILICON CHIP, March, April & May 2007), as it combined all three of my interests into one project. I immediately went to Jaycar to get the kit.

Today I finished the project. I simulated the input with a signal generator and the MAP with a pot and watched both the input and output on a dual-trace CRO. The dwell was spot-on as programmed and it was a real joy to see the advance (in ms) on the CRO correspond exactly with the advance (in degrees) as entered on the hand-held unit.

That PIC microcontroller is truly an impressive technological advance over the 8086 and Z80 chips I used in university! All went well on the bench and I will be putting the unit in my car as my next project but I expect all will go well.

So, thank you very much to John Clarke and your magazine for this and many other interesting and outstanding articles. Keep up the good work.

Dave Comfort,
via email.

Poor mains connections can interfere with digital TV

I had problems with my digital TV which was intermittently troubled with drop-outs and errors on weak signals. I don't know if the signal transmission to my area was recently boosted at the transmitter or if it was fixed by the sequence of events I will describe now.

I tried every thing I could think of: AC filtering, upgraded to double-shielded aerial cable, antenna amplifiers, new antenna and a new earth stake just for the TV. Nothing worked.

Then I had the fusebox upgraded with ELD (electrical load detection) and due to this change the MEN system used on the garage switchboard had to be removed and the earth separated from the neutral there. At the same time it was noted that the supply fuseholder was slack on the fuse cartridge (on the barge board of the house). The holder was tightened.

After all this electrical work was done the problem with the TV is now fixed. I suspect the loose mains connection was the principle cause. This might help other technicians in the struggle against spurious noise faults.

Norm Boundy,
Melbourne, Vic.

couple of days. When we get to our new site, not only do we have to reset the clock but we also have to input all our favourite shows back into the timer record menu.

(3) Two remote controls for all new AV equipment? One remote would have all the functions on it (to be stored away and only used when unusual functions required.)

The second, smaller remote would have only the major function keys on it. With only 10 or so keys it could be made in big bold colours so that the elderly and visually-impaired could use it. If it gets broken, you would still have a spare.

And while we are on this subject why can't the most often-used keys (Play, Stop, FF, FRW, Vol Up, Vol Down, Channel Up, etc) be more prominent on the remote? Make them bigger, coloured or raised; anything to make it easier to use. You should not have put on glasses just to change channel! In addition, battery compartment covers should be screwed on, not clipped on, as it is far too easy for the covers to fall off and be lost.

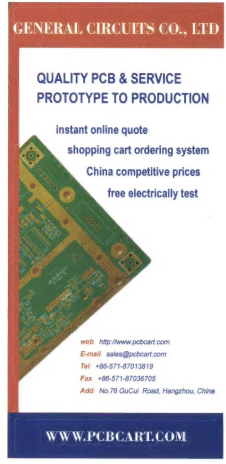
(4) Actual temperature set-up on portable fridges? Most 12V fridges (Engel, Waeco, etc) have a temperature readout that lets you see what the inside temperature is. If it is too cold, then you have to adjust the control to make it a little bit warmer or vice versa.

Why don't they make it so that you set the display to the actual temperature you want? Simple! No more constantly monitoring the fridge to make sure the beer is the right temperature. It seems to me they have all the necessary electronics installed; it's just not configured correctly.

(5) Devices that work faster, not slower than older models? In the past, when you turned something off or on, it did so right away. Now most modern appliances have to think about things for inordinate lengths of time before something happens. With DVD players, press eject and it takes up to a minute before it deigns to open the tray. What's the hold-up? If it's playing, just stop the disc spinning and open up. What's so hard about that?

Modern CTVs take forever to auto tune the stations. I cannot, for the life of me, figure out why some manufacturers set the search speed for TV stations at such a slow rate. If Sony, Teac, and other Japanese brands can do it quickly, why not the other Asian makers? Modern notebooks and laptops take forever to boot up. It seems to be an evolutionary thing – they make faster chips, which are then hamstrung by bigger and slower software, ad infinitum.

Another issue with modern CTVs is sound quality. I would like to know who decided that we had to have flat panel sets as thin as possible, with tiny speakers and no bass response at all. If installing big speakers with sufficient baffling, to provide a decent sound, required the set to be 100mm deeper, then so be it. My main concern is listening enjoyment, not how far it sticks out from the wall.



OCEAN CONTROLS
Helping to put you in Control
Control Equipment

Arduino Uno
This new arduino comes fully assembled and tested with ATMega328 preloaded with bootloader. The Uno uses an ATmega8U2 for USB to serial connection. **SFA-100 $35 +GST**

Labjack U6 Data Acquisition Module
Feature packed includes USB connection, 14 Analog Inputs (16-18+ Bits Depending on Speed) , 20 Digital I/O, Up to 4 Timers, 2 Counters and 2 Analog Outputs. Free Software and drivers **LAJ-041 $425.00 +GST**

Industrial Flashing Light Tower Our flashing LED multi-level signal light has Red, Yellow, Green lights and a Buzzer. Powered from 24VDC the lights flash at approximately 1Hz. **HEL-020 $64.95 +GST**

6 Digit Counter This programmable 6-digit counter is also a batch counter and totaliser, performs quadrature counting and accepts remote reset. Has relay and pulse outputs. **NOV-400 $129 +GST**

Float Switch
Industrial grade float switch with 10m lead. Has both Normally open and closed contacts. Suitable for raw water and sewerage. **HES-100$39.95+GST**

Led Message Display Gateway Want to display readings so they can be read 30 metres away. Our gateway displays messages from your PLC or microcontroller onto a large 1 line 20 character display. Led display also available. **KTA-270 $159+GST**

Contact Ocean Controls
Ph: 03 9782 5882
www.oceancontrols.com.au

Mailbag: continued

Lead-free solder & cable glands

With regard to the letter about Toyota engine runaway (Mailbag, October 2010, page 4), there have been several previous instances of engine runaway. I have been involved with car clubs for over 40 years and think that there have been some instances here with some other models some time ago. A lot of the auto technology here is way behind overseas manufacturers.

I strongly believe that the rise and rise of the use of that rubbish called lead-free solder is and will be a significant problem. I am already seeing it and often wonder if the tin whiskers that it suffers from is the cause of the automotive issues.

I have already seen this stuff fracture and recently was presented with a bench-type multimeter, cap tester etc that was doing bizarre things and the display was quite unstable. I pored over the circuit board with a magnifier to see if there were any dry joints as that is still the number one cause for this sort of thing and various other hassles. As a consequence of what I saw I grabbed a stiff brush that I felt would not be electrostatic and brushed the board, paying particular attention to the chip. It now works.

I also have a faulty circuit board from a coffee maker on the bench. This is the second board (other was a Megger) where a sloppy worker has left splatter and splinters of solder all over the board. No wonder they play up.

Secondly, I was outraged at the almost ridiculous Nannyism demonstrated in the comment re the grommet used for anchoring the power cord in a Vintage Radio article. Those are approved glands for mains cabling. I tend to use those glands by the dozen but I remove the rubber. The nut is actually a ratchet type and is not that easily undone. I do use the cord-grip type but in many cases, with the poor quality nibblers available and the size of hole you can cause more damage than enough trying to fit them. Meddlers will not be stopped, irrespective of what you use.

My only issue with Rodney's effort was that he put it in the wrong way around. In many chassis it is better to put the clamp nut on the inside, if space allows or it has a back. It is too easy to break if it's protruding.

As for the comment re soldering the earth. From what I have seen in several hundred radios of all ages, there is more chance of a loose corroded bolt and Hell freezing over than there is of a good solder joint lifting off of the chassis. Many of the factory fitted 3-wire cables were soldered. Even the separate earth wires were soldered, often next to a bolt. I have even seen earthed binding posts with a wire from them to a soldered ground.

Marcus Chick,
Wangaratta, Vic.

Comment: as far as we are aware, a cable gland is not an approved method of anchoring a mains cable to a chassis. Certainly, we have never seen any commercial equipment that uses a cable gland in this role.

(6) Equipment that is at least as reliable as 20 years ago? Modern electronics is abysmally unreliable, compared to just 10 years ago. In a quest for lighter and cheaper power supplies, we have swapped proven reliable designs for the current lot of cheap and nasty designs. Old-style power supplies had a transformer followed by a bridge rectifier, filter network and the regulator. These parts were seldom replaced and had excellent qualities in regard to power surges, overload, and reliability.

By contrast, modern switchmode supplies rely on small electrolytic capacitors that have proven to be the most unreliable of all modern electronic components.

Nearly all modern equipment relies on cooling fans to remove excess heat. The benefits of this method of cooling are small cabinet size as no bulky heatsinks are needed. But after

a few years, fans will get blocked with dust, bearings or (if the fans are cheapies) bushes will seize and the electronics will be subjected to much higher temperatures than they can handle and will fail. Some flat screen plasma TVs have more than six fans installed. If you wanted to come up with a planned obsolescence system, then this scenario is perfect.

Laurie Bell,
Echuca, Vic.

Bad design in LED torches

I was interested to read the letter in "Ask Silicon Chip" (October 2010, page 95) regarding batteries for a LED torch. From my experience, short battery life may be due to poor design. A few years back, my children had a small keyring, single-LED torch. When the batteries went flat, I opened it up to find out what the batteries were, to obtain replacements. This torch was powered by two button batteries in series.

What took me back when I looked inside was that the torch had no limiting resistor. The batteries were simply connected directly to the LED via the pushbutton switch. I can only assume that the batteries' internal resistance was the only thing stopping the LED being destroyed. Some time later a friend purchased a similar but differently constructed keyring single LED torch and when he opened it up, he found the same thing – no resistor.

The switch on a multi-LED torch that we keep in a handy place in the kitchen for power failure etc was intermittent, so I dismantled the torch to see if I could repair it. The battery holder held three AAA batteries in series (4.5V) and the LEDs were mounted in parallel on a small circuit board. Once again the battery holder was simply connected via the switch directly to the LED board.

As part of my repair, I fitted an appropriate resistor. The only bright note (no pun intended) in the story was

Compact fluorescents have no warranty in oyster fittings

Two months ago I purchased a box of Philips Genie 14-watt compact fluorescent lamps. One of them lasted 360 hours (about 45 days) and failed. My concern was that the other lamps would also fail before the manufacturer's claim of three years of life.

After ringing the call centre and answering some questions, I was informed that the lamp was not covered under any warranty claim as it was in an enclosed fixture (Glass Oyster fitting). In small print under the top cover of the box flap it says, "Specified performance measured in 220-240V", and another one saying "Not suitable for enclosed fixtures". These statements cannot be seen by a purchaser until they open the package.

This is very annoying to me and I wonder how many other consumers are being caught by this packaging. Note that this product is also endorsed by "PLANET ARK".

Name & address supplied but withheld at the writer's request.

Custom Battery Packs, Power Electronics & Chargers

For more information, contact

SIOMAR BATTERY ENGINEERING

Phone (08) 9302 5444 or email mark@siomar.com

www.batterybook.com

ProtoGEAR
Order online at
www.protogear.com.au
email: sales@protogear.com.au
Development Boards for PIC, AVR and heaps more! Freescale coming soon!
Programmers, Cables, Chips, Serial Converters, Solar Cells, GPS
Brushless Motor Kits - Wind your own! Stators, Flux Rings, Wire, Magnets
Awesome Sparkfun Gear - Breakout boards, kits, and heaps of other gear
We specialise in gear to help prototype electronic circuits. We're landing heaps more stock every week, so be sure to check back and see what we have in store!
WOW! FIRST 25 ORDERS RECEIVE 20% OFF!

Specialist loudspeaker drivers from:
GERMANY
VISATON®

With over 40 years of experience in acoustics and speaker technology, Visaton are a market leader. They offer a huge range for almost any speaker project. Comprehensive data is available online. Ph. (02) 4627-8766 or (03) 9859-0388
- Drivers up to 15"
- Fullrange & wideband
- Miniature & shielded
- Horns & coaxial drivers
- Hifi - DIY - Projects
- Communications
- Public Address
- Manufacturing
soundlabs GROUP
www.soundlabsgroup.com.au

Mailbag: continued

when I had a look at the insides of a rather nice anodised metal-bodied multi-LED torch, belonging to our youngest daughter. I could see a surface-mount resistor on the back of the LED board. So, out of four different torches only one did the right thing!

The other thing I thought I would comment on was in a letter by Ranald Grant about the Quad amplifier and ESLs (Mailbag, October 2010, page 4) where he referred to "the late Professor Ed Cherry . . .". As an employee of the Electrical Engineering Dept of Monash University, I think we would have been definitely informed if the good Professor had passed on! Incidentally, Ed and his wife were living in Marysville when the Black Saturday fires came through. Miraculously their home was one of the very few that survived that terrible tragedy.

I think Mark Twain once was reported to have said "The reports of my death are grossly exaggerated".

Ray Chapman,
Pakenham, Vic.

Criticism of circuit explanation

I am very happy to see the number of microprocessor-based articles in SILICON CHIP recently. I particularly like the project article on "An Intelligent 12V Fan Controller" (SILICON CHIP, July 2010) but I am very disappointed in the "Buck Converters Explained" side box. This explanation is over-simplified to the point of being misleading.

Rather than enhance understanding it promotes confusion. Inductors do not limit current, they limit the rate of change of current. There is no spike of current through the inductor, rather the current ramps up or down depending on the voltage across it.

Certainly SILICON CHIP must pitch their articles to their perceived audience but to my mind the uninitiated will find your explanation steers them away from understanding, rather than giving them any insight into how buck converters or indeed inductors work.

Peter King,
Doncaster East, Vic.

Giving up on soldering

I think I have had something of a religious conversion. In the past I enjoyed assembling digital chips and wire to make things but after a couple of decades working with strip board it has become all too tedious. I finally have to admit it, microcontroller boards are the way of the future.

SILICON CHIP has had many PICAXE projects but by the time you add an IC socket, circuit board and power supply the price of a minimal PICAXE project starts to mount. But for NZ$40 I can purchase a fully-built Arduino-compatible board, ready to go with multiple power options, USB connectivity, 14 pins of digital I/O and eight analog inputs. There is also a large market for "solderless" Arduino-compatible add-ons such as RF devices, cellular modems, GPS modules, motor drivers and even network connectivity that can be used without lifting a soldering iron.

Compressed Natural Gas for cars

I need to comment on the Publisher's Letter which proposed the use of natural gas as a transportation fuel.

Natural Gas (NG) is a very high octane (no lead), clean burning, cheap fuel. Unfortunately being a gas causes some practical problems. It needs a heavy high-pressure cylinder (typically rated around 8000 psi) and needs to be compressed to around 2000 psi to get any practical quantity. The result for a vehicle is heavy cylinders, small fuel quantity and hence a short driving range.

The other problem is that a lot of energy is required to compress NG to 2000 psi and these compressors are expensive. However, it is feasible to use off-peak electricity to run these compressors overnight.

One promising technological solution is the recent creation of molecular sponges (Google "methane MOFs"). Basically, the same volume and quantity of 2000 psi NG can be stored at only 200 psi in a MO, resulting in much lighter cylinders and far less energy to compress NG.

Unfortunately, the real impediment is not technical but government greed. Over 20 years ago, I talked to someone from "All Gas" who had recently been to Canberra. It was at the time of lead and smog concerns in our cities and just before the introduction of lead-free fuels and mandatory catalytic converters. He thought he had a winner; cleaner exhausts; cheaper fuel that repaid the cost of converting vehicles to CNG; figures from real vehicles supporting his petition, etc.

But NO! The whisper he got was that Canberra was addicted to petrol tax. At that time petrol was about 50c/litre (25c tax) and the equivalent energy in NG was only about 1-2 cents. Today, petrol is around $1.30/litre (65c tax); the equivalent energy in NG costs about 5c.

As well as CNG for transport, I would also like to see the extension of reticulated gas networks into suburbia, especially because of the threat of electricity price rises.

J. Williams,
Carrara, Qld.

The speed of design and implementation for small projects is reduced from a weekend to an evening. Building a project then just becomes a matter of interfacing with sensors and any output devices and then writing software. The April 2010 project for an Arduino-based I/O Controller almost hit the mark but fell just a little bit short as it included a full on-board implementation of an Arduino controller.

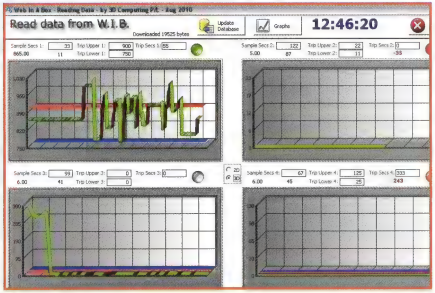
Would it not make more sense for the project to interface onto a discrete Arduino board? The total project cost would be significantly reduced and it would be much simpler to assemble and test.

For more complex digital systems the only sensible

DYNE
INDUSTRIES PTY LTD
Now manufacturing the original ILP Unirange Toroidal Transformer
- In stock from 15VA to 1000VA
- Virtually anything made to order!
- Transformers and Chokes with Ferrite, Powdered Iron GOSS and Metglas cores
- Current & Potential Transformers
DYNE Industries Pty Ltd
Ph: (03) 9720 7233 Fax: (03) 9720 7551
email: sales@dyne.com.au
web: www.dyne.com.au

into PICS?
There's something to suit every PIC practitioner in the SILICON CHIP reference bookshop
PIC Microcontroller – know it all (Newnes)
Newnes have put together the best of subjects their authors have written on over the past few years into this one handy volume!
$90
The PIC Micro – personal intro course by John Morton
Practical guide which assumes no prior knowledge. So it is an ideal introduction for hobbyists, students and teacher alike.
$60
PIC in Practice – by DW Smith
Based on popular short courses for the PIC for professionals, techs, hobbyists, students and teachers. Ideal introduction to PICs.
NEW LOWER PRICE!
$60
You'll find many more technical titles in the SILICON CHIP reference bookshop – see elsewhere in this issue

Mailbag: continued



Windows interface for WIB project

I have written a Windows-based program to interface with my WIB. It graphs the temperatures and caters for alarms to be set.

I thought some of your readers might like to play with it, so I have put it up on a web page for anyone to download. You can download it directly – it's at **http://www.3d.com.au/wib/WibReader.Zip** which is an *exe* and a *chm* help file. The help documentation is separate from the zip file at **http://www.3d.com.au/wib/wib.chm**

Kevin Benson,
via email.

way to design and test is to use a Field Programmable Gate Array (FPGA). For less than the cost of a good soldering iron I've acquired an FPGA development board which is equivalent to around 500,000 discrete logic gates and with many megabytes of RAM and flash ROM. All of this hardware can be "virtually" rewired in a few minutes using no-cost software tools.

The other great feature is that you can run simulations of your designs on your PC and debug most problems without expensive test equipment.

To me, it seems that any project that uses more than a handful of digital ICs is no longer relevant – even the popular Web Server In A Box (WIB) becomes unappealing when compared to such things as a $200 single-board PC (eg, a PC Engines ALIX 3D3), possibly connected to a Velleman USB Experimenter's Interface Kit. For me, the time spent assembling the kit (which includes soldering SMD components) just isn't time well spent.

If SILICON CHIP is to remain relevant for aspiring electronics professionals or serious hobbyists it should focus on what this technology now allows. SILICON CHIP should aim to have a regular article in each issue on how to interface a digital system to a class of device and perhaps should even start publishing projects that can be used with FPGAs. Failing this, any digital projects in SILICON CHIP will become a nostalgic journey to a bygone era, much like reading Vintage Radio.

Mike Field,
Springston, NZ.

Comment: Arduino and Arduino-compatible boards are very attractive to those people who are skilled in programming in C but they are not so practical for many of the projects featured in SILICON CHIP magazine.

Really, Arduino is a very useful tool but in practice, you have to add other circuitry to it, ie, op amps, Mosfets, relays and so on, to make it do what you want. Our projects would not be

nearly as attractive and easy to build if they were based on an Arduino board which then had to be hooked up to another board to provide all interfacing.

And while many SILICON CHIP projects do use microcontrollers, many do not and Arduino and FPGAs are not suitable and would be overkill.

Easy solution for poor TV sound

Regarding your Publisher's Letter on poor TV sound (SILICON CHIP, July 2010) and subsequent correspondence on the topic, I recently bought a new Samsung 106cm plasma TV and was very disappointed with the tinny sound quality. I simply connected the 3.5mm stereo headphone output to an audio amplifier and good speakers. This was the simplest fix. It disconnected the TV speakers and provided great stereo sound.

I have found a lot of TV brands have a headphone output socket which will not necessitate the purchase of a new home-theatre system or digital-to-analog converter.

Chris Rogers
Pakenham, Vic.

Getting goods posted from the USA

In the Eye-Fi review (October 2010), Ross Tester details the difficulties he encountered ordering an Eye-Fi card, with virtually all the online sellers refusing to post one to an address outside the USA.

There is a website called **myus.com** which, for a small annual fee, will provide you with a mailing address in the USA. They will then forward packages sent to that address on to you and bill you for the cost of postage.

Hopefully this will help readers who run into the same problem in future. They also have a service (for an additional fee) that allows you to combine multiple packages into a single on-shipment.

Lyle Barry,
Campbelltown, NSW. SC

Resistor colour codes can be hard to read

I had an experience with a PICAXE interface which might help someone out and in non-PICAXE situations as well.

I had been programming PICAXEs with the same set of resistors and diode for the last few months and they sit permanently connected to a ZIF socket. The other day a small-ish download started and suddenly stopped at about the 20% mark (on a 20X2). Several retries and a quick check gave the same result. Then, with a new 20X2 chip, it again failed immediately.

Again I looked at the interface – nothing else was connected to the 20X2. The sole difference, known from the beginning, was that I have always used 20kΩ resistors in the interface instead of 22kΩ as I have so many of them.

I wondered if going to 22kΩ as specified would be the difference, though it has never mattered before and measured it to check it was within tolerance. However, they were 30kΩ, not 20kΩ, and obviously wrongly marked as the first and fourth band were clearly red. I had bought a pile of these 18 months ago at a good price, to ensure I had an ample quantity of all values.

Now, I am not colour-blind – not even slightly. It was a high tolerance, blue, metal film resistor (practically all I use now) though I dislike them slightly as colours are not always as easy to determine (especially white/grey and sometimes even black/brown). Even sitting near a window, that orange band still looks red; to my wife too.

But no, it was orange as I poked about to find a high tolerance 22kΩ. When side-by-side you can see a difference between orange and red – but only if they are side by side. So, should anyone report flaky downloads for no known reason, ask them to measure the 22kΩ resistor with a meter.

Brett Cupitt,
Ashfield, NSW.

Comment: those blue resistors can be hard to read – that is why we suggest that people always check values with a DMM.

Kinsten Presensitized PCB & associated products

IN STOCK NOW!

- Single Sided Presensitized PCBs
- Double Sided Presensitized PCBs
- Fibreglass & Phenolic
- UV Light Boxes
- DP50 Developer
- PCB Etch Tanks, Heaters & Aerator Pumps
- Thermometers
- Ammonium Persulphate Etchant
- PCB Drill Bits (HSS & Tungsten)

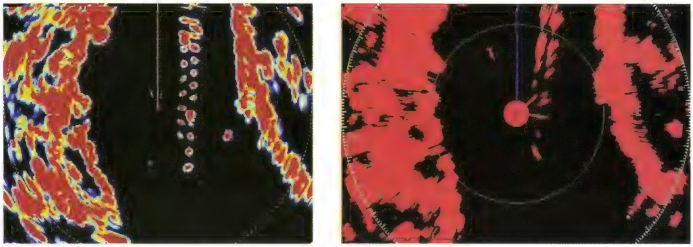
WILTRONICS
36 Years Quality Service

For full range, pricing and to buy now online, visit
www.wiltronics.com.au
Ph: (03) 5334 2513 Email: sales@wiltronics.com.au

Broadband Radar: A quantum leap forward

By Kevin Poulter

Mariners have always needed to know the quickest and safest route between where they are and where they want to be – and what obstacles might be encountered on the way.



This comparison of Broadband vs Pulse radar shows a line of mooring poles. In the Broadband image (left) there's a boat moored between the fourth and fifth poles – a fact completely missed by the pulse radar. In fact, it's having a hard time differentiating the poles! Just as important is the "blind spot" immediately around the pulse radar, masking close craft.

Radar systems, first used during WWII, are commonplace on larger, ocean-going vessels but for quite a number of reasons – cost being a major one but also the inherent danger of traditional radar signals – they haven't been found on too many smaller craft.

With the exception of tall-masted vessels, keeping boat users and radar signals separated isn't easy!

The electronics age has revolutionised small boat use with accurate positioning guaranteed, collision avoidance systems, depth sounders, world-wide radio contact, AIS and much more.

But now there's a new player in the game: Broadband Radar, which promises to revolutionise navigation for vessels of all sizes – at a price that is significantly lower, bringing it into the range of the casual yachtsman or recreational fishing boat owner.

Not only that, it's dramatically safer to use than existing (pulse) radar systems.

Broadband Radar utilises technology similar to that used in military and IMO-certified radar applications – unlike anything else on the recreational marine market.

Designed from the ground up, Broadband Radar is not an improvement on old designs, rather its a completely new design.

Consumer FMCW (Frequency-Modulated Continuous Wave) Broadband Radar technology was introduced during 2009. It came after more than five years of intensive research, development and testing, even when one manufacturer 'threw in the towel' as too hard/too expensive.

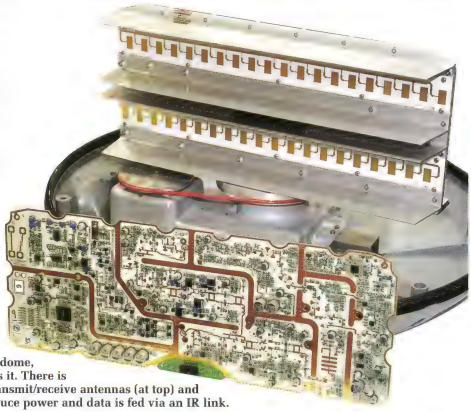
It was developed by Navico, the world's largest marine electronics company, which has five leading marine electronics brands: B&G, Eagle, Lowrance, Northstar and Simrad. Broadband Radar is available in three of their brands: Northstar, Lowrance and Simrad.

Broadband Radar systems clearly differentiate between docks, channel markers, pilings, moored vessels and other important targets.

Target resolution is from <10m up to 13km (7 nautical miles), depending on the size of the object.

Broadband Radar is far more than a minor upgrade.

FMCW radar technology is not new – it's existed for as long as traditional or "Pulse" radar systems (using the



Inside the Navico Broadband Radar radome, along with the electronics which drives it. There is no physical connection between the transmit/receive antennas (at top) and the drive system – spinning toroids induce power and data is fed via an IR link.

magnetron) have. It's commonplace, especially in military radar where expense is not a constraint.

But in the leisure market FMCW was not used at all until last year, as it was considered too expensive.

Traditional radar

Traditional "pulse" radars use high-powered magnetrons to generate microwave signals with very short pulses.

Cavity magnetrons, which consist of a hot cathode with a high-pulsed negative potential activated by a high voltage, direct-current power supply, are one of the most common devices on earth – every microwave oven is based on one!

Pulse Radar transmits an enormous pulse of microwave energy. Because it has a single antenna, Pulse Radar is 'deaf' for a brief period during and immediately after transmitting, as the receive circuitry must be turned off to prevent being overloaded by the transmitting pulse.

Therefore it cannot 'see' at close range. After the RF Pulse, it turns off and goes to 'listen' mode. On a typical boat the resultant 'blind spot' is typically within about 10 – 15m of the vessel. Some units cannot even see within 30m.

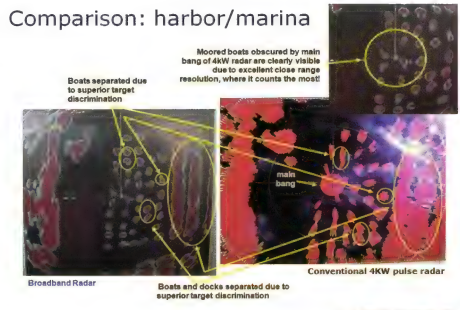
The high-power radar pulses, being microwave energy, are also dangerous at close range, so must be used away from where people are, or can go, on the vessel. This significantly reduces mounting options.

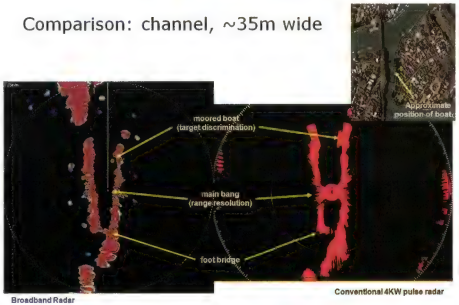
Also, Pulse Radar emissions are particularly 'dirty', polluting the radio spectrum, with significant unwanted transmitted frequencies each side of the desired frequency.

Another major disadvantage of Pulse Radar is its warm-up time – the magnetron filament must be heated for it to work, just like the vast majority of thermionic devices.

This delay can be as much as 2-3 minutes – a significant safety consideration. Two minutes can be a long time when you're worried about a collision. The alternative, leaving it on standby all the time, wastes a lot of power which is often unacceptable, especially on power-limited vessels such as yachts.

Leaving the unit on also ages the magnetron's filament. It has a finite life – typically around 3000-4000 hours – after which time it will either burn out or lose emission – either one of which will render the radar useless until the quite expensive Magnetron is replaced.





FMCW radar is a whole new technology

Unlike pulse radar, FMCW radar is instant-on and has no filament to burn out.

Nothing beats Broadband Radar in the most vital navigation scenarios, such as coming into port at night, with possibly fog in the atmosphere too.

The skipper may be navigating between boats, moorings and jetties, adding to the need to see at close range. FMCW can see within metres of the boat – the very objects that pose the greatest threat of collision – plus smaller targets, like a pole or fibreglass canoe. There's a saying: 'All collisions happen at zero metres'.

Dramatically lower power

Despite the high-definition improvements, Broadband Radar transmits a minuscule 100mW continuous – around 1/20,000 the power of typical pulse radars! To put that in some form of perspective, that's around a tenth of the peak power a mobile phone radiates.

Therefore the Broadband Radar radome (antenna) is safe to mount almost anywhere, in locations never before possible. You can even hug the radome during transmission!

Lower power equals lower battery drain.

With such low transmit power, the unit is easy on the battery, with only

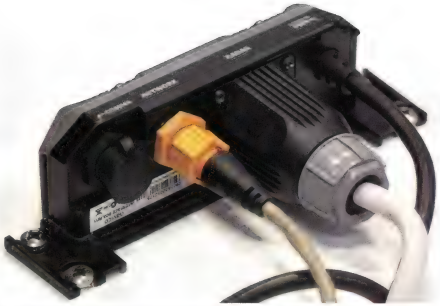
about 14W consumption. Achieving the lowest DC power drain of any X-band marine radar makes Broadband Radar ideally suited for vessels with limited power, like sailboats.

The beauty of being solid state is the unit can be turned right off and activated only when you want to make a sweep.

Lower range – but clearer!

Looking at the average power of a 2kW Pulse Radar, it's sending out 2,000 pulses per second – average that out and it's about 80 to 120 watts. The pulse radar has a range of about 44km (24 nautical miles).

Broadband Radar does not cover such a range – it's limited to about 5 to 7km – however, images are in high-definition and as mentioned, they are down to very close to the vessel, where it really matters.



The ethernet junction box which allows the system to accept a range of other inputs, such as sonar, audio, side-scan radar and so on.

Interference

Because other boat's FMCW Radars have the same technology, two antennas 'looking' at the same data at the same time could cause interference. However, in practice, this is almost unheard of. At worst, you see a single line across the screen, radiating from the centre out, which would only last for a short time.

Sea clutter

Sea clutter, or unwanted reflections from waves, is a major problem in conventional radar for areas close to the boat.

Traditionally, pulse radar has been detuned slight to eliminate sea clutter but this potentially causes legitimate targets to be missed. Highly improved range discrimination in FMCW radar allows it to scan smaller areas of the sea and so receive less unwanted reflection from waves in that area. Any small target amongst those waves will show up more clearly.

The multi-pupose visual display has broadband radar on the left and Navico's Sonar on the right. Highlighted is a shipwreck, clearly indentified on the screen.

Expansion

The display unit is a modular type system, utilising ethernet in the antenna/scanner, expanding functionality through an ethernet junction-box.

There are three ethernet connections across the back of the junction-box, enabling other devices to be attached, such as audio, engine management, autopilot control, AIS transceiver and much more can be connected.

How it works

Navico's first-generation Broadband solid-state X-band radar technology utilises Frequency Modulated Continuous Wave (FMCW) techniques, by sending a continuous transmission wave with linearly increasing frequency.

If those transmitted waves intercept an object, some are reflected back to the radar's receiver.

The difference between the currently transmitted and received frequencies, coupled with the known rate of frequency increase, is the basis for precisely calculating a "time of flight" and target distance. This system provides target detail superior to pulse radars, while transmitting at far lower energy levels.

No slip rings

In the scanner/antennas, there are two rotating toroids creating a transformer effect, transferring power from the bottom to the top. In the middle of the two toroids there's a high-speed

infrared data link.

The installation height is a balance between the 'line of sight' advantage of being high up and the benefit of seeing close targets, achieved best by a lower installation height. So ocean-going vessels generally have a higher installation while for inshore, lower height is best.

This offers more flexibility – because it's safe, the unit can be installed lower, with no adverse affect from radiation. On a Maritimo boat, for example, the Transponder is mounted quite low on the flybridge, on the arches. This would definitely not be safe for a Pulse Radar installation.

Interface box

To make it installation as easy as possible, even for the home boat handyman, Navico developed a unique interface box for their Broadband Radar. With standard radar, there's connections such as the power cable, heading information to the radar plus ethernet cable.

Installers like Broadband Radar with its plug'n'play installation. Other advantages are a lightweight design, low electromagnetic interference due to low emissions (which keep regulatory authorities happy) and of course a longer life.

Narrow band, wide frequency sweep

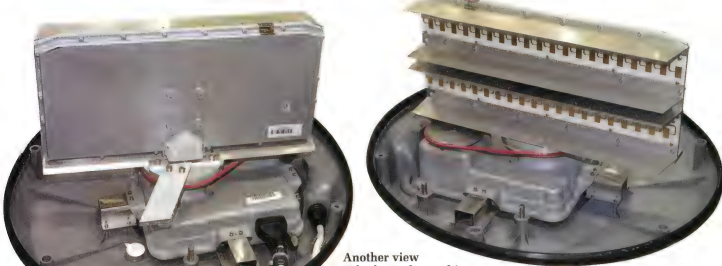
Broadband Radar operates in the 9GHz Marine X-Band. Specifically, the transmit frequency is swept over a bandwidth of 65MHz between 9.30GHz to 9.38GHz. That's intended to keep clear of X-Band Pulse Radars and their 'dirty big bangs' of about 10-20MHz bandwidth.

One of the key performance measures of any radar is its 'range discrimination' – the ability of the radar to discriminate between two close targets in range. Range discrimination for any radar is proportional to the bandwidth of the transmit/receive signal.

A narrow bandwidth signal produces poor range discrimination, while conversely, FMCW's wider bandwidth produces best range discrimination.

In some operation modes Broadband Radar does transmit a narrower band signal. In these cases Navico uses "frequency-hopping", a spread-spectrum technique, to spread the energy transmitting across the entire

Simrad's NSE12 visual display here shows the Broadband Radar but can display a wide range of data that will extend its capabilities – for example, an echosounder/fishfinder, AIS transceiver, autopilot control, engine performance display and much more – all accessible from a single screen.



Another view inside the Radome, this this time showing rear (left) and front (right) views. Of particular interest is the double antenna seen clearly from the front, one section for transmitting and one for receiving. The signal processing is all achieved within the Radome and is fed to the display via an Ethernet connection.

available band. This reduces interference between radars.

The receiver

Conceptually the receiver is quite simple. It mixes the transmitted signal with the received signal that has bounced off a target. This received signal will be a delayed, producing a 'difference' or 'beat' frequency that's proportional to the delay (and therefore also proportional to the distance to the target).

The Broadband Radar unit then performs "Fourier analysis" of the 'beat' signal (using an FFT) to identify target responses in the signal.

While conceptually the principle of FMCW radar is quite simple, the implementation can be quite involved. Since the radar is transmitting at the same time as it's receiving, the transmitter has to be extremely low noise, so weak returns from distant targets are not obscured by noise from the radar's own transmitter.

Also a very high dynamic range is vital, so the receiver can process the large signals from close targets while at the same time processing the weak signals from very distant targets.

The system design for the radar is quite different to a conventional radar. A conventional radar uses only one antenna, however because Broadband Radar transmits at the same time as receiving, two antennas are grouped in the one housing, one for transmit and one for receive.

With a single conventional antenna, it's relatively easy to couple the transmit/receive signal (in the base of the radar) to the rotating antenna through a rotary joint using a waveguide.

With two antennas, Navico mounted the transmitter and receiver on the back of the rotating antenna.

Navico does this because the aim is to detect the very faint returns from distant targets at the same time as transmitting.

The receiver circuitry has no problem in removing the transmitted signal but the distant echos are so faint that they can get swamped by noise from the transmitter. By using separate antennas, the coupling of the noise from transmitter to receiver is reduced, making this problem significantly easier to overcome.

Nevertheless, the RF transmitter has exceedingly low noise characteristics to meet the performance goals.

Broadband Radar picks up surfboard riders

Every waterway has hazards particular to it – and the passage out to the open sea from the Gold Coast Broadwater, known as the Seaway, is no exception.

In addition to fast-moving tides, Gold Coast boaties making their way out to sea know they have to keep a sharp look-out for surfers paddling across the Seaway to and from a popular break on South Stradbroke Island.

The surfers are particularly hard to see when the swell's up – which is unfortunate, given that's when surfers are most likely to be out searching for waves!

Last year, the Navico Australia team was heading out to sea to continue trials on its new Broadband Radar, the BR24. To everyone's amazement, the radar picked up an image long before those on board spotted it: a group of surfers paddling across from South Stradbroke Island – even though the surfers were flat on their boards and had radar profiles of no more than about 30cm above the sea!

Clearly, Navico's BR24 Broadband Radar takes precision radar to a whole new level.

The 'beat' frequency signal is sampled by a 16-bit ADC. This digitised signal is then processed by a signal-processing chain implemented in an FPGA (Field Programmable Gate Array).

The signal-processing chain performs Fourier analysis plus a number of other signal processing operations including interference suppression and rejection, sea and rain clutter filtering, equalisation for range, target-tracking and conversion to a 4-bit-per-pixel protocol for transmission on an Ethernet network.

The display reads the radar data off the Ethernet network, applies a colour palette and performs a Cartesian-to-polar conversion to generate the standard radar PPI (Plan Position Indicator) that most people associate with radar.

The price?

Compared to pulse radar, Broadband Radar is exceptional value for money, even disregarding the clear operational advantages.

First you buy the multi-pupose visual display screen and then add on what you need – including Broadband Radar of course!

The entry-level 5-inch HDS screen, intended for smaller craft, is $1000 and the BR-24 radar is currently $1999 RRP, or $3,000 for a full system.

For larger boats, the system with 12-inch NSE Screen plus BSM-1 (Sounder Module) and BR-24 is $8299 RRP.

Acknowledgement

Our thanks for assistance in the prepartion of this feature to:

Kevin Soole, *Program Manager, Navico Auckland*

Andrew Corbett, *R&D Manager, Navico Asia Pacific*

Estelle Baldry and Damien Weber, *Navico Australia*

and Ben Sandman. SC

Further information:
Contact Marine Dealers, or Navico at **www.navico.com**

Dick Smith - Your Comple

AVAILABLE MID DECEMBER

Dick Smith Digital Indoor Active Antenna
A compact, indoor digital active (amplified) TV antenna that covers all Australian UHF and VHF channels. Suitable for good to strong signal receiving areas. In weaker areas, an external antenna is recommended. L4476

$59.97
NEW

VIEW LIVE FOOTAGE IN YOUR 3G iPhone

Swann
Advanced security made easy™

DVR4-2500 Security Recorder System with Internet Viewing
- 500GB hard drive
- Up to 50ft (15m) night vision
- 4 CCD cameras - view and record 4 channels simultaneously
- USB backup. L6187

$1119
SAVE $80

Swann
Advanced security made easy™

Deluxe Gold Camera Pen 2GB
Take still photos or shoot colour videos with audio then upload straight to your PC. Features internal 2GB USB flash memory and long lasting 90 minute battery. L6169

$78

Logitech

PS3 Harmony Adaptor
Works with Harmony remotes to give you the power to use your remote to control your home entertainment system, including your Playstation®3. L6503131

$59.95

Logitech

Harmony Universal Remote Controls
A. Harmony 300 Remote L6303A $49.95
B. Harmony 650 Remote L6503A $129.95 EXCLUSIVE

Dick Smith 4-Way Universal Audio Video Switch Selector
Plug 4 AV devices into this unit, plug the unit into the TV, and switch between them without having to unplug anything! L6680

$29.99

Dick Smith 2-way HDMI™ Switcher
Expand the number of HDMI™ slots in your HD TV or monitor. Easily switch between two HDMI™ devices without the hassle of unplugging cords. Remote control included. L6460

$59.98

Dick Smith Flexible Cable Tidy Wrap Kit
This handy cable management sleeving kit is so simple to use as it easily zips down, pushing loose cables into the wrap with the supplied tool. To unwrap, simply peel and zip apart! 1.8m long, supplied with Zip Clip tool, 4 stick-on wall mount clips and 14 equipment ID labels. L6270

$15.98

digitor

High Quality Digital TV Coaxial Cable - 20metre Roll
Quality 75 Ohm RG6U quad shield coaxial cable. Ideal for Digital TV, Pay TV and Satellite TV. Great for low signal areas. W2987

$33.73
SAVE $11.26

Looking for your nearest Dick Smith store?
Head to dicksmith.com.au!

te Technology Destination

144 Amazing Educational Science Station Kit
Features over 144 educational experiments. It's a creative way to teach realistic concepts of electronics and electricity. KE039

$49.99

NEW

288 Amazing Science Centre
288 experiments! A creative way to teach children realistic concepts of electronics and electricity. KE040

$59.99

NEW

MECCANO

Meccano 15 Multi Model Set $44.99
Builds 15 different models and is suitable for ages 8+ KE565

MECCANO

Meccano Motion System 30 $69.99
You will have hours of fun were you can make up to 30 different moving models using the 352 pieces in this superb kit. Comes with 6V motor and gear boxes to create cool constructions. KE561

MECCANO

Mechanical Auto Workshop $99
Build 25 different models! This special edition set is dedicated to the automotive theme. 727 pieces. KE327

Deluxe HD Microscope Set $29.99 NEW
New Generation Die Cast HD Microscope with wide-angle eyepiece for easy viewing, quick and precise focusing mechanism and strong durable base. KE018

National Geographic Bug Barn $29.99
Children will love the world of insects up close. Analyse the insects with your high-powered magnifier, observation room, tweezers, canister and net. KA626

NATIONAL GEOGRAPHIC

Outdoor Explorer Kit and Night Vision Goggles $29.99
Explorer kit contains binoculars, compass, torch and magnifying glass and cut-out nature quiz cards. KE022. Night Vision kit contains high gain sonic ear listening device, automatic volume limiter for safe sound level, and high powered flashlight. KE023

National Geographic Star Planetarium and Explorer Projector $59.99
Transforms a room into a 360 degree space theatre. Learn how to recognise stars and watch the stars move across the ceiling or learn about the underwater world with this explorer projector. KE024 Planetarium. KE025 Projector

Offers starts 25/10/10 and ends 30/11/10 or while stocks last. All offers are for retail store stock only, with strictly limited stock available. Some items may not be available for mail orders, stock movements between stores and back orders. No rainchecks. No layby. Enthusiast electronic items are not available in all stores. Offers may not be available in some reseller or franchise stores. Please contact your local store to determine availability.

dick smith
Talk to the Techxperts

Hearing Loop Level Meter

Setting the correct signal level and minimising noise are critical factors when setting up a hearing loop. This easy-to-build tester can display field strength levels over a 27dB range. Here's how it works, how to build it and how to use it.

Pt.1: By JOHN CLARKE

WHEN INSTALLING a hearing aid loop, it is important to set the magnetic field strength to the correct level. This ensures that a hearing aid with a Telecoil (or T-coil) will deliver the best signal-to-noise ratio without signal overload.

The same applies if you are using a hearing loop receiver such as the one described in the September 2010 issue of SILICON CHIP (or a commercial equivalent).

Additionally, when setting up a hearing aid loop, it is important to verify that any background magnetic noise is at an acceptable level. Both background noise and signal strength from the hearing aid loop can be measured with this Hearing Loop Tester.

Of course, if you are setting up a small hearing loop in your home, you can usually get away without using a level meter. In that case, it's usually just a matter of setting the level to give good results from the hearing aid without any overload occurring.

However, for a system that will be used by more than one person or the general public, it is important for the level to be correct. That way, the loop will be suitable for all who use it.

Specifications

Power supply: 9V at 18-26mA

Display: –21dB to +6dB in 3dB steps

Meter response: "S" (slow) response of 1s

Weighting: A-weighting or wide (see Fig.4)

Main features

As shown in the photos, the SILICON CHIP Hearing Loop Tester is housed in a small hand-held plastic case that includes a battery compartment. A power switch and an indicator LED are located on the top panel, while the front panel carries 10 bargraph LEDs arranged in a vertical column on the lefthand side.

In operation, this bargraph displays signal levels ranging from -21dB to +6dB, with each LED representing a 3dB step. However, to conserve battery life, the display is normally set to dot mode which means that only one display LED is lit at any time. The current consumption is 18mA when no bargraph LEDs are lit and 26mA when one bargraph LED is lit. This is quite satisfactory for an instrument that is normally only used for short durations.

Alternatively, you can install a link under the PC board to convert to a conventional bargraph display. This is not recommended though, due to the increased current drain.

An important feature is that the unit can be accurately calibrated to indicate 0dB at a field strength of 100mA/m. This specification is based on the Australian Standard AS60118.4-2007 – "Hearing Aids: Magnetic Field Strength In Audio-Frequency Induction Loops For Hearing Aid Purposes".

Once calibrated, the meter can then be used to set the field strength level in a hearing loop to the correct level. It can also be used to measure the

environmental background noise, to determine whether this is low enough for a hearing loop to be successful.

In operation, the unit is simply held at right-angles to the plane of the hearing loop for both signal level and noise measurements.

Circuit details

Refer now to Fig.3 for the circuit details. It's based on four low-cost ICs, an inductor (L1), 11 LEDs and a handful of minor parts.

Inductor L1 is used to detect the magnetic field from the hearing loop. This inductor is actually an Xenon flash-tube trigger transformer (Jaycar MM-2520) which has a high inductance, suitable for loop monitoring.

In this circuit, we use only the secondary winding of L1, which is wound as an autotransformer. This winding has an inductance of about 8.4mH and is biased at about 4.15V using two 10kΩ resistors connected in series across the 8.3V supply. A 100µF capacitor bypasses the divider output.

The 4.15V half-supply rail is also used to bias pin 5 of op amp stage IC1b (via L1). This allows IC1b's pin 7 output to swing symmetrically about this half supply rail.

L1's coil resistance is 27Ω and, in conjunction with the 100µF bypass capacitor, it presents a low source impedance to IC1b's pin 5 input at low frequencies. This minimises any low-frequency noise. The inductor's impedance increases with increasing frequency but this is restricted by a parallel 2.2kΩ resistor.

This 2.2kΩ resistor lowers the Q of the inductor, thereby preventing oscillation. A 220pF capacitor at the output of L1 also shunts any high-frequency signals to ground.

IC1b is configured as a non-inverting amplifier stage with nominal gain of 1001, as set by the 100kΩ and 100Ω feedback resistors. However, one aspect of using an inductor to receive the hearing loop signal is that the signal induced in L1 rises in level with frequency. This is because the induced voltage is proportional to the rate of change of the magnetic field.

As a result, IC1b's gain is reduced with frequency in order to achieve a flat overall frequency response. This is achieved by using a 33nF feedback capacitor and 100kΩ feedback resistor to roll off signal frequencies above about 50Hz by 20dB per decade. This counteracts the 20dB per decade increase from the inductor.

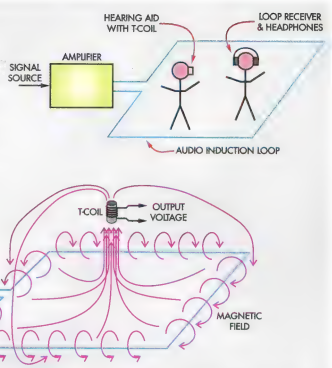


Fig.1: the basic arrangement for a hearing loop. The loop creates a varying magnetic field in response to the driving signal and this is picked up by suitably-equipped hearing aids and receivers.

Fig.2: this diagram illustrates the magnetic field generated by the hearing loop and shows how it couples into a hearing-aid T-coil.

In addition, IC1b's low-frequency gain is rolled off below 723Hz using a 100Ω resistor and 2.2µF capacitor connected in series between pin 6 (the inverting input) and ground. If link LK1 is installed, an extra 22µF capacitor is placed across the 2.2µF capacitor and this lowers the low-frequency roll-off point to around 66Hz.

Op amp IC1a provides a further stage of gain. If trimpot VR1 is set to its minimum, IC1a's gain is 1+ (100kΩ/150Ω) or about 667. However, if VR1 is set to its maximum value of 5kΩ, the gain is reduced to about 20. This range of gain adjustment allows the meter to be calibrated.

IC1a's high-frequency roll-off starts at about 10.6kHz due to the 100kΩ resistor and 150pF capacitor in the feedback path. In addition, both IC1b & IC1a have inherent reduced gain at high frequencies. IC1a's low frequency roll-off depends on the setting of VR1 and occurs somewhere between 10.6Hz and 0.32Hz.

A-weighting

The high and low roll-off frequencies set for IC1b with LK1 out of circuit produce a nominal A-weighted overall frequency response for the level metering. A-weighting is a tailored response that's designed to match the way our ears perceive loudness with respect to frequency at a particular low-level sound pressure. The weighting rolls off the signal below and above 1kHz as shown in the graph of Fig.4.

Inserting link LK1 extends the frequency response of the unit down to at least 200Hz, before rolling it off at the lower frequencies. As explained later, this wider response is better for checking background noise levels than the A-weighted curve. **As a result, we recommend that LK1 be installed for all measurements (including loop level measurements), to provide a nominal frequency response of 200Hz to 10kHz (-3dB points).**

In fact, the relatively flat response of the meter between 200Hz and 5kHz with LK1 in is ideal for checking hearing loop response levels. If necessary, treble boost can be applied to the loop amplifier to counter the effect of drooping high-frequency response due to the loop inductance.

Precision rectifier

IC1a's output is fed via a 100nF capacitor to a full-wave precision rectifier stage based on IC2b, IC2a and diodes D4 & D5. The capacitor rolls off the response below about 106Hz. This

Parts List For DAB+/FM Tuner

1 remote control case, 135 x 70 x 24mm (Jaycar HB5610 or equivalent)
1 PC board, code 01111101, 65 x 86mm
1 panel label, 55 x 14mm
1 panel label, 113 x 46mm
1 miniature PC mount SPDT toggle switch (S1)
3 DIP8 IC sockets (optional)
1 DIP18 IC socket (optional)
1 Xenon flash tube trigger transformer (Jaycar MM2520 or equivalent) (L1)
1 2-way pin header (2.54mm spacing)
1 jumper shunt for pin header
4 M3 x 5mm screws
1 9V (216) alkaline battery
1 9V battery clip
1 40mm length of 0.7mm tinned copper wire
2 PC stakes
1 5kΩ horizontal trimpot (code 502) (VR1)

Semiconductors

2 TL072 dual op amps (IC1,IC2)
1 LM3915 log bargraph driver (IC3)
1 7555 CMOS timer (IC4)
1 1N5819 1A Schottky diode (D1)
4 1N4148 diodes (D2-D5)
1 3mm red LED (LED1)
2 3mm orange LEDs (LED2,LED3)
8 3mm green LEDs (LED4-LED11)

Capacitors

1 470µF 16V PC electrolytic
4 100µF 16V PC electrolytic
1 22µF 16V PC electrolytic
3 10µF 16V PC electrolytic
1 2.2µF 16V PC electrolytic
1 1µF 16V PC electrolytic
1 100nF MKT polyester
1 33nF MKT polyester
1 1nF MKT polyester
1 220pF ceramic
1 150pF ceramic
1 10pF ceramic

Resistors (0.25W, 1%)

1 1MΩ	4 10kΩ
1 300kΩ	3 2.2kΩ
1 150kΩ	2 150Ω
2 100kΩ	1 100Ω
2 15kΩ	1 10Ω

Helmholtz coil

2 836mm lengths of 2.4mm diameter steel fencing wire (or similar stiff wire)
1 piece of timber, approximately 65 x 19 x 200mm
1 33Ω 0.25W resistor
1 wire clamp made from two solder lugs or metal scrap
4 small rubber feet (optional)
1 400mm length of medium-duty hook-up wire
1 1m length of shielded cable
1 3.5mm stereo jack line plug
4 solder lugs
3 small wood screws

stage works as follows.

When the signal from the 100nF capacitor swings positive, pin 7 of IC2b goes low and forward biases diode D4. As a result, IC2b operates as an inverting amplifier stage with a gain of -1, as set by the 15kΩ input and 15kΩ feedback resistors on its pin 6.

This inverted signal at D4's anode is applied to IC2a's inverting input (pin 2) via a 150kΩ resistor. This stage operates with a gain of -6.66, as set by the ratio of the 1MΩ feedback resistor and the 150kΩ input resistor. As a result, the total gain for the signal path from pin 1 of IC1a to pin 1 of IC2a via IC2b is -1 x -6.66 = +6.66.

In addition, the positive-going signal from IC1a is applied to IC2a via a second signal path, ie, via a 300kΩ resistor. For this path, IC2a operates with a gain of -3.33 and so the overall signal gain from the output of IC1a to the output of IC2a is +6.66 - 3.33 = +3.33.

Now consider what happens for negative-going signals from IC1a. In this case, diode D5 is forward biased and so IC2b's output is clamped at about 0.6V above its pin 6 input. As a result, no signal flows via D4 and IC2b ceases operating as an inverting amplifier.

This means that negative-going signals from IC1a are fed to IC2a via the 300kΩ resistor only (ie, via only one signal path). Because IC2a operates with a gain of -3.33 for this path, the signal is inverted. Therefore, the precision rectifier provides a positive output for both positive-going and negative-going signals from IC1a and both have a gain of 3.33.

IC2a also provides low-pass filtering of the signal so that its response is slow to incoming signal level changes. The time constant is around one second (1s) as set by the 1MΩ feedback resistor and its parallel 1µF capacitor. This matches the slow (S) response requirement for measuring background noise for a hearing loop system.

Bargraph circuit

IC2a's output is fed to the pin 5 input of IC3, an LM3915 10-LED bargraph driver with a logarithmic response. The bargraph displays a 27dB range with each LED covering 3dB. We have labelled the display so that is covers field strength levels from +6dB down to -21dB

As explained previously, the unit is calibrated to read 0dB at a field strength of 100mA/m.

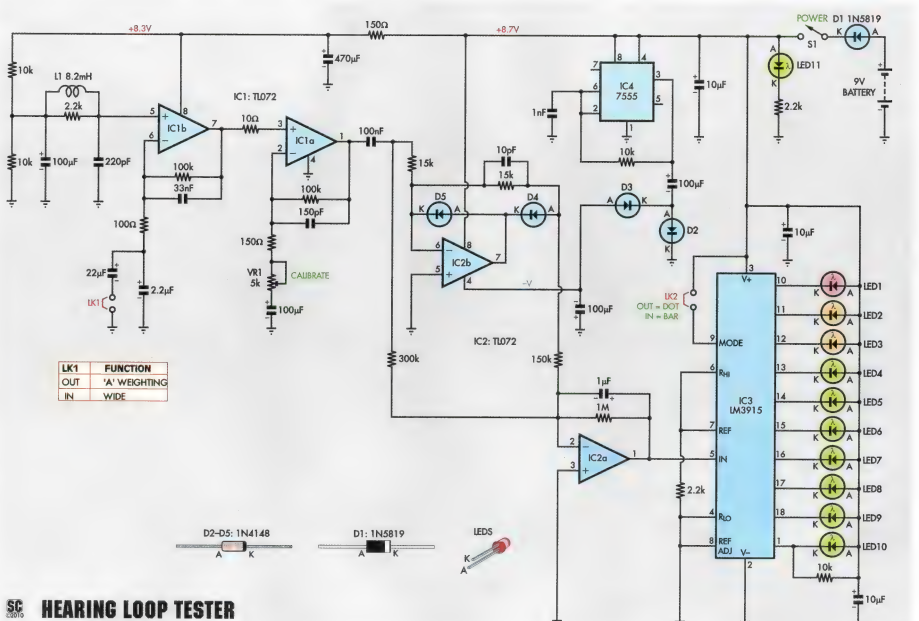
The voltage range for the meter display is from 1.25V at full scale (+6dB) down to about 56mV for the -21dB LED. This range is set by connecting the R_{HI} input to the 1.25V reference (pin 7) and the R_{LO} input to ground (0V). The 2.2kΩ resistor between REF (pin 7) and ground sets the bargraph LED current to about 6mA. Link LK2 sets the bargraph mode.

Power supply

Power for the circuit is derived from a 9V battery, with diode D1 providing reverse polarity protection. S1 functions as a power switch, while LED11 is used as a power-on indicator. The 2.2kΩ resistor in series with LED11 limits the current through it to about 3.5mA.

The resulting 8.7V rail is filtered using a 10µF capacitor and directly supplies IC2, IC3 & IC4. IC1's supply is also derived from this rail but is decoupled using a 150Ω resistor and a 470µF filter capacitor. This is done so that supply variations due to changes in the LED bargraph display are not introduced into IC1, which contains two sensitive amplifier stages.

A negative supply for IC2 is generated using 7555 timer IC4, diodes D2 & D3 and two 100µF capacitors. IC4 is wired as an astable oscillator and operates at about 72kHz due to the timing components on pins 6 & 2, ie, a 1nF capacitor to ground and a 10kΩ resistor which is connected back to pin 3.



SC 03/10 HEARING LOOP TESTER

Fig.3: the circuit uses inductor L1 to detect the magnetic field generated by the hearing loop. The resulting signal is then amplified by IC1b & IC1a and fed to a precision rectifier based on IC2b, IC2a and diodes D4 & D5. The output from the rectifier then drives IC3 which in turn drives the 10 LEDs in the bargraph display. Power comes from a 9V battery, while IC4 and diodes D2 & D3 generate a -7V rail for op amp IC2.

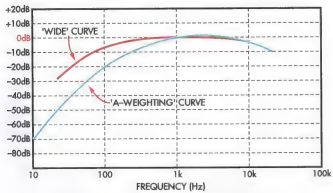


Fig.4: this graph shows the frequency response of the Loop Tester with LK1 installed (wide) and with LK1 removed (A-weighting).

It operates like this: when power is first applied, pin 3 goes high and the 1nF capacitor charges via the 10kΩ resistor. When it reaches 2/3rds the supply voltage, the pin 3 output goes low and the capacitor discharges until it reaches 1/3rd the supply voltage. Pin 3 then switches high again and so the process repeats indefinitely while power is applied.

As well as charging/discharging the timing capacitor, pin 3 also drives the negative supply circuit. When pin 3 goes high, it charges its associated 100µF capacitor to the positive supply rail (+8.7V) via diode D2. Then, when pin 3 of IC4 subsequently switches low, the positive side of the 100µF capacitor is pulled to 0V. As a result, its negative side goes to -8.7V (or thereabouts) in order to maintain the charge across the capacitor.

This negative voltage now charges the second 100µF capacitor via diode D3 to provide the negative rail for IC2. The actual rail voltage obtained depends on the load and the voltage drops across the two diodes but, in practice, will be close to -7V.

Construction

All parts except for the battery are mounted on a single-sided PC board coded 01111101 (65 x 86mm) and this assembly is housed in a remote control case measuring 135 x 70 x 24mm. Two labels are attached to the front and top panels to give a professional finish.

The PC board is designed to mount onto the integral bushes inside the box. Check that the top edge of the PC board has the corner cut-outs so that it fits correctly. If necessary, you can make the cut-outs yourself using a small hacksaw and then carefully filing them to shape.

Fig.5 shows the parts layout on the PC board. Begin by carefully checking the board for any breaks in the tracks and for shorts between tracks and pads. The four mounting holes and the two holes that are used to anchor the battery clip leads should all be 3mm in diameter.

The assembly is best started by installing the two wire links and the resistors. Table 1 shows the resistor colour codes but it's also a good idea to check each one using a digital multimeter (DMM).

Follow with the diodes, taking care to orientate them as shown. Note that D4 & D5 face in opposite directions. That done, install two PC stakes to terminate the battery clip leads.

Next, install DIP sockets for ICs1-4 with their notched ends facing in the directions shown (note: IC3 faces the opposite way to the others). The ICs can then be fitted, taking care to ensure that IC4 is the 7555. Alternatively, you can solder the ICs straight in.

The 2-way header for LK1 can now go in, followed by the capacitors. Be sure to install the electrolytics the right way around and keep their heights above the PC board to less than 12.5mm, otherwise the lid of the case will not fit correctly. If necessary, sit the electrolytics up off the board slightly and then bend their bodies over after soldering.

Trimpot VR1, switch S1 and inductor L1 are next. Note that a third (thin) wire attached to L1 is soldered to a spare pad on the PC board.

Installing the LEDs

LEDs1-10 must be installed so that the top of each LED is exactly 15mm above the PC board. This can be done by cutting a 10mm-wide cardboard spacer which is slid between the leads during soldering. Take care with the orientation (the anode is the longer of the two leads) and be sure to push each LED down onto the spacer before soldering it in place.

Note also that LED1 is red, LEDs2 & 3 are orange and LEDs4-10 are green.

The power LED (LED11) is installed so that it sits horizontally with the centre of its lens 6mm above the board. To do this cut a 6mm-wide cardboard spacer, then bend the LED's leads down through 90° 12mm from its base, making sure that the anode lead is to the left. The leads can then be inserted into the PC board and pushed down onto the 6mm spacer before soldering.

Now for the battery clip. This is installed by first passing its leads through the battery compartment and

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	1MΩ	brown black green brown	brown black black yellow brown
❑	1	300kΩ	orange black yellow brown	orange black black orange brown
❑	1	150kΩ	brown green yellow brown	brown green black orange brown
❑	2	100kΩ	brown black yellow brown	brown black black orange brown
❑	2	15kΩ	brown green orange brown	brown green black red brown
❑	4	10kΩ	brown black orange brown	brown black black red brown
❑	3	2.2kΩ	red red red brown	red red black brown brown
❑	2	150Ω	brown green brown brown	brown green black black brown
❑	1	100Ω	brown black brown brown	brown black black black brown
❑	1	10Ω	brown black black brown	brown black black gold brown

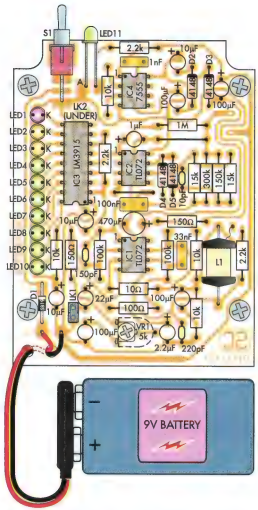


Table 2: Capacitor Codes

Value	µF Value	IEC Code	EIA Code
100nF	0.1µF	100n	104
33nF	.033µF	33n	333
1nF	.001µF	1n	102
220pF	NA	220p	221
150pF	NA	150p	151
10pF	NA	10p	10

Fig.5: install the parts on the PC board as shown on this diagram and the photo at right. The bargraph LEDs must be installed using a 10mm cardboard spacer – see text.

then looping them through the holes in the PC board as shown. This anchors the leads which can now be soldered to the PC stakes (watch the polarity).

The PC board can now be secured to the base of the case using four M3 x 5mm screws into the integral mounting bushes. That done, attach the label to the top panel and drill the clearance holes for the power switch and indicator LED.

If the label is not supplied as part of a kit, you can download the artwork in PDF format from the SILICON CHIP website.

You will also need to drill 10 x 3mm-diameter holes for the bargraph LEDs in the lid. These holes must line up along the inside border of the inset section on the top lid. Note that the label does not extend fully to the left side of this inset and so it does not need to be drilled.

If you are building this project from a kit, then the labels will probably be supplied. If not, the downloaded PDF files can be printed out onto photo paper with a peel-away adhesive backing or onto clear plastic film. If using clear plastic film (eg, overhead projector film), you can print the label as a mirror image so that the ink is at the back of the film when it is placed onto the panel.

Wait until the ink is dry before cutting the label to size. The film can then be affixed in place using an even smear of neutral-cure silicone sealant. If you are affixing the label to a black coloured panel (eg, if using the specified case), use grey or white-coloured silicone so that the lettering will stand out.

The holes for the power switch and indicator LED in the top label can be cut out using a sharp hobby knife after the silicone has cured.

Testing

Before applying power, go back over your work and check for wiring errors. That done, connect a 9V battery, switch on and check that the power LED lights. If not, then either D1, LED 11 or the battery is the wrong way around (or a combination of these).

Assuming the LED does light, check that pin 8 of IC1 is at about 8.3V (assuming that the battery itself measures 9V). Similarly, check that pin 8 of IC2 is at about 8.7V and that pin 4 is at about -7V. Pin 3 of IC3 should be at 8.7V, as should pin 8 of IC4.

If these supply voltages check out, touch the bottom lead of inductor L1. This should cause some of the LEDs in the bargraph to light due to the noise introduced into op amp IC1b. Note: it can take several seconds for the unit to display a bargraph reading immediately after switch-on.

That's all for this month. Next month, we'll give the calibration procedure and describe how the unit is used. SC

Putting it together . . .

DIGITAL LIGHTING CONTROLLER

Part 2 – by Nicholas Vinen and Jim Rowe

Everyone who has seen this has been pretty impressed . . . and no wonder! While we originally intended it to make your Christmas Lights display the best in your suburb, with up to 32 channels and total power limited only by your power outlets, it's capable of controlling just about any lighting sequencing task you want to throw at it. Now we get on with the good stuff: putting it all together!

We introduced this new Digital Lighting Sequencer last month and already it's created quite a stir. So how many budding Chevy Chase wannabes are there out there, anyway?

This month we'll go through the relatively simple construction of both master and slave units, testing them and then how to use them. We'll start with the smaller of the two "boxes", the Master Unit which has all the "smarts".

Master board construction

Before assembly, check the copper side of the PC board for defects and that the holes are drilled correctly. Test the connectors for fit. If your board is not provided with the corners cut out to suit the case, you will need to file it to shape.

First install the SD/MMC card socket, which goes on the copper side. Remove the dummy plastic "memory" card, then place the socket over the pads. Check that they all line up, then apply some solder to the two larger mounting pads. Ensure it is aligned and that it is sitting flat on the board – if required, re-melt the solder joints and adjust its position.

Once it is in place, apply solder to the 13 remaining pads, ensuring that the solder flows properly onto both the

Above is the master unit with a 128MB SD card in its reader. This is connected via a suitable length Cat5 cable . . .

pins and the pads. In the case of the Altronics socket, one of the mounting pads has two pins (one is ground) so make sure that the solder covers both.

After that, install the wire links using either tinned copper wire or 0Ω resistors. Follow with the resistors as shown on the overlay, checking each value with a multimeter before installation. Then fit the four diodes, taking care with their polarity.

Next is the 28 pin socket for IC1 with the notch orientated as shown on the overlay. Solder two diagonally opposite pins and then check that the socket is sitting flat on the PC board before soldering the rest. Then straighten the pins of the TL072 IC and solder it in place, oriented as shown.

Using small pliers, bend the legs of the LM3940 regulator down at right angles 6mm from the tab. Attach it to the board using a 6mm M3 machine screw, shakeproof washer and nut. Once it is firmly mounted, solder the leads and then trim them.

After that, mount the 3.5mm stereo socket. Ensure its pins are straight before inserting it and check that it sits flat before soldering them.

Fit the MKT and ceramic capacitors next. Polarity does not matter but the values do, so check the overlay diagram as you go. Follow with the single tantalum capacitor. The positive lead is normally marked with an inked "+" on the plastic body, which lines up with the "+" on the overlay.

Now install all the electrolytic capacitors except the largest (2200µF). The 4.7µF non-polarised capacitor can go in either way but the rest must have their longer leads (+) through the hole marked "+" on the overlay.

Install the 7806 regulator next, using the same procedure as for the LM3940 but before you insert the M3 machine screw, slip the small heatsink between the regulator and the PC board. Thermal grease is not required. Make sure it stays straight as you tighten the bolt, otherwise it may touch the large capacitor which will be adjacent to it.

Unless the 2200µF capacitor lies flat it is too tall to fit in the box. Bend its leads down about 2.5mm from its base, keeping in mind its final orientation (as shown by the + symbol on the overlay). Push it flat against the board, solder it in, then run a thin bead of neutral-cure silicone sealant or hot-melt glue along the side closest to the board edge to hold it in place.

Now fit the crystal adjacent to IC1. Its orientation does not matter but avoid heating its leads too much.

Next install the DC socket, ensuring that it is flush against the PC board and is at right angles with the board edge in both planes. Follow with the RJ-45 socket – push its plastic posts into their holes, then carefully solder the eight pins without bridging them. If you do manage to create a solder bridge, it can be cleaned up with solder wick.

The green LED is installed at right-angles to the PC board and in line with the edge. Bend its leads 6mm from the body, using the overlay as a guide as to the final orientation – the flat side should be lined up as shown. Solder it so it sits 7mm above the board surface.

The infrared receiver needs its leads bent twice. With the dome of the lens at the front, bend the leads 90° backwards 1mm from the component body, then back in the opposite direction 7mm from the first bend, forming a "Z"-shape. Push the remaining leads all the way through the PC board before soldering them so that the 7mm section rests on the top.

Testing the master board

Before installing IC1, check that the power supply is working. Temporarily connect a 9V AC plugpack to the power socket and measure the output (rightmost pin) of both regulators relative to the tabs – they should be close to 6V and 3.3V. Assuming they are OK, remove the power supply and wait a few seconds, then install the microcontroller (IC1), being careful to line up its notch with that on the socket.

Re-apply power and the green LED should flash twice then continually ramp its brightness up and down. This tells you that the microcontroller and its zero crossing detection circuitry are working.

If the LED does not flash, check that IC1 has been programmed correctly and the crystal is correctly installed. If it does not pulsate, check the passive components in the zero crossing detection circuit.

Assuming all is OK, place a WAV file (in the standard PCM format, eg, from a CD) on an otherwise blank

. . . to the slave unit, which contains the drive circuitry for the lights. Up to four slave units can be connected in series, giving a total of 32 channels. For a full explanation, see last month's intro.

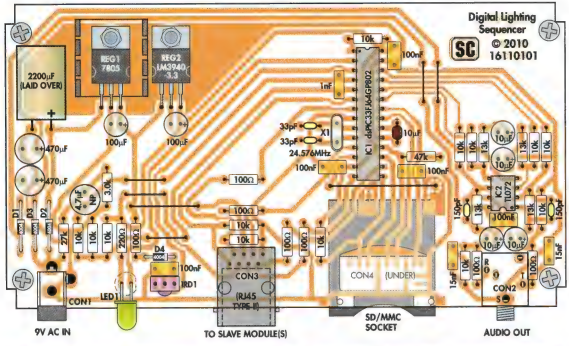
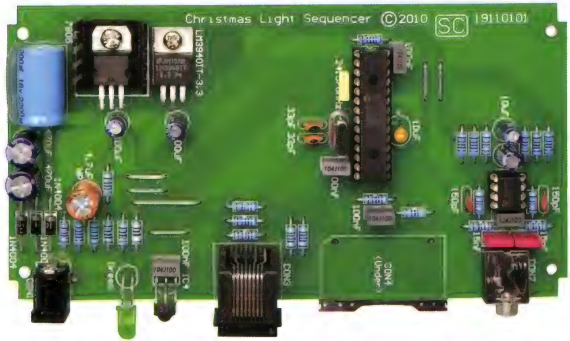


Fig.4: here's the component overlay for the master unit, with a matching photo underneath. Two points to note: (a) the SD card socket is mounted on the underside of the PC board, and (b) the 2200µF capacitor is mounted lying down on the PC board, with some hot melt glue or silicone sealant to hold it in place (after soldering!). We strongly suggest you use a socket for the microcontroller at least – it makes testing and trouble-shooting a whole lot easier. Note that there are some minor differences between the early prototype PC board at left and the component overlay above.



memory card and plug it in. The green LED should go out (it may flash twice first) and after a few seconds it should turn on fully.

If so, connect the audio output socket to an amplifier (eg, using a 3.5mm to RCA cable) with the volume turned down then slowly turn the volume up. If you hear the audio being played then the card, socket and audio output are all operating correctly.

If the LED is on but there is no sound, check the audio output circuitry. If the LED does not turn on as described then there may be a problem with the soldering on the card socket. If LED flashes repetitively in a pattern, this indicates that the software has encountered an error – see the table of error codes towards the end of the article.

Completing the master module

Snap the front panel off the box and cut and drill it as shown in Fig.5. A photocopy or print-out of this template can be temporarily glued onto the panel as a drilling aid.

For the round holes, drill a small pilot hole in the centre and then expand it using a series of larger drill bits, then de-burr it using a larger drill bit. This ensures that the holes remain round and clean.

For the larger rectangular hole, mark the outline using a sharp knife and then drill a series of closely spaced 3mm holes around the inside of the outline, then cut the remaining plastic to knock out the centre section.

Use a needle file to clean up the edges and slowly expand the opening until the connector fits neatly.

The card slot can be made using a similar technique but the holes must be small (eg, 1.5-2mm) to avoid going outside the outline. Once the slot has been filed to a rectangular shape you

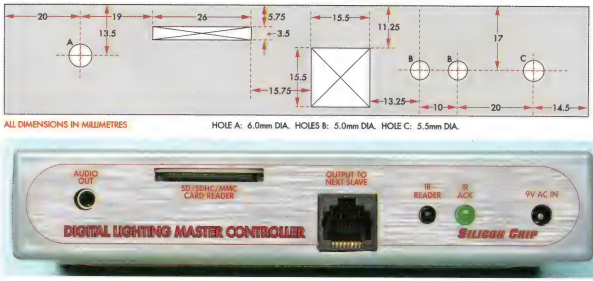


Fig.5: same-size diagram showing the holes and cut-outs for the master unit. The photo below shows the same thing, this time assembled.

may need to slightly elongate it in one direction or the other after the case is assembled to suit the alignment of the card socket.

Now mount the PC board in the case. It is attached to the lid's integral plastic stand-offs with nylon washers between them, so that the memory card can clear the lip on the lid. Place the Nylon washers atop the stand-offs then lower the PC board on top without knocking them off. Attach the board using the specified self-tapping screws.

If you can't get the board on with the washers staying in place, you can glue them to the underside of the board with a dab of hot-melt glue or other adhesive. They must be slightly offset from the centre of the holes so they do not extend out past the board's corner cut-outs.

With the board installed, one further cut-out must be made to the base lip. The specified RJ45 socket is quite tall and requires a notch, as shown in the close-up photo. Gently trim away the plastic using side-cutters and clean it up using a file. Care must be taken to avoid cracking the case or scratching the panel – the lip itself is hidden by the front panel when it is installed.

At this point, with the lid in place, the front and rear panels can be snapped on and the master module is complete. Note that when attaching the front panel you will need to lever it in place – clip on the edge with the RJ45 cut-out first.

In doing so be careful that the LED fits through the hole, otherwise its leads will be bent. Also check that the infrared receiver sits properly behind its hole with the front panel is in place.

Once you have confirmed that all the cut-outs are correct and the front panel fits properly you can stick the label in place. If it is not adhesive (eg, if you have printed and laminated it) it can be attached with a thin smear of silicone sealant.

Slave board construction

Again, check the copper side of the board, then install the wire links. There are ten in the low voltage (bottom) section and these can be made from tinned copper wire or 0Ω resistors.

The eight links near the Triacs are at mains potential, so they must be insulated. Cut eight 11mm lengths of the 2.5mm or 3mm fibreglass sleeving and slip each over a 20mm length of tinned copper wire. Bend the ends of the wire to form 11.5mm wire jumpers and then solder them in place. When that is finished, install all the resistors. Use the colour code table provided and/or check each with a multimeter before installation to be sure that they are the correct value.

Next fit the three ICs and eight optocouplers. The ICs all have different pin counts so it is hard to mix them up but be careful with their orientation (see the overlay diagram). Straighten the leads and press each IC down as far as it will go before soldering it. The orientation of the optocouplers is critical so be sure to install them with the notch towards the left side of the board, as shown on the overlay.

Now solder the two low-voltage MKT capacitors (at the bottom left) and the two electrolytic capacitors. The longer lead of each electro goes into one of the two holes near the "+" symbol.

After that you can install the terminal blocks, with the openings facing towards the nearest edge of the board. Follow with the X2 capacitors, then the two RJ45 connectors. They are installed in the same manner as with the master board. Ensure they are pressed down fully before soldering them.

The eight red LEDs are next but first their leads must be bent at right angles 7mm from the lens. The anode (the longer lead) must go towards the right edge of the board, so bend them in the correct direction to achieve this. The horizontal portion of the leads go 16mm above the board surface. A 16mm-wide strip of cardboard can be cut to assist in positioning them.

Fit the Triacs to the heatsinks in pairs – one on either side. Insert a 10mm x M3 screw through one tab, then the heat sink, then the other tab and secured with a shakeproof washer and M3 nut. Do them up tightly. As before thermal grease is not necessary

This notch needs to be cut in the case to accommodate the RJ-45 socket. Cut it as neatly as you can but don't worry too much if your skills aren't up to scratch: it's hidden by the front panel.

The assembled slave unit, ready to be wired (as shown later) and fitted to its case. Never be tempted to work on the PC board with power applied – always have the lid on the case. At right is Fig.6, the component overlay for the slave unit.

but may be used if desired. Note that the tabs on these devices are insulated – do not substitute other Triacs!

Once each Triac/heatsink assembly is complete, push the leads through the holes in the PC board until the heatsinks are right against the board, then flip it over and solder the two thick posts to hold the assembly in place.

Because the heatsinks are quite large you will need to use a large tip and/or high temperature for this job. When the heatsinks are in place you can then solder and trim the Triac leads.

Now fit the toroidal inductors. Push each pair of leads through the board as far as they will go then solder and trim them.

Finally, install the earth lug. If you spade terminal is double-ended, cut one end off first with a pair of sturdy side-cutters. Place a shakeproof washer over an M3 x 10mm machine screw and insert it through the earth mounting hole from the copper side. Place the lug over the shaft, then an M3 nut. Tighten it, with the lug orientated so that the cable won't interfere with any components. Add a second nut on top (to act as a locknut) and do it up firmly too.

Testing the slave module

Test the low voltage section of the slave module before installing it in the case. Download the test data from the SILICON CHIP website (1611010T.zip) and extract it into the root directory of a blank memory card.

With the master module power disconnected, connect the slave board to it using a short Cat5 cable. Make sure the slave board is resting on a non-conductive surface and check that you have plugged the cable into the correct (control input) connector.

Plug the card into the master module and apply power – ***do not connect the slave module to mains!***

After a brief delay, you should see the LEDs on the slave module light up in turn for two seconds each. This repeats, then after a ten second delay, it goes into a loop where each LED fades in and out in turn.

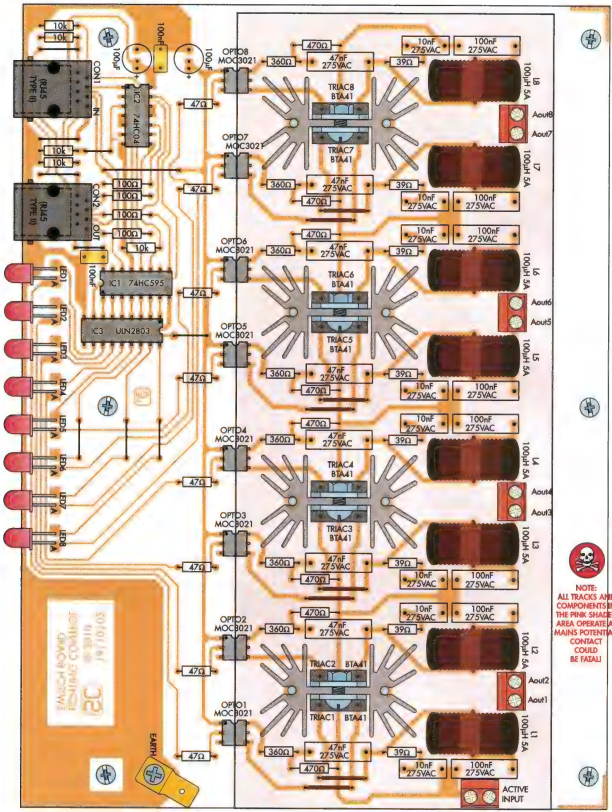
If some of the LEDs do not light, check the corresponding LED, optocoupler and current limiting resistor for errors. If none of the LEDs light then there is a problem around one of the digital logic ICs or one of the RJ45 connectors.

Slave module assembly

Now prepare the front panel, using Fig.9 as a guide. As with the master module, the round holes can be drilled while the others can be made by drilling a series of holes within the outline, knocking the centre out and filing them to shape.

Be careful to make the IEC connector cut-out accurately as a tight fit will ensure that it can't come loose.

After that, attach the front panel label. For maximum protection from grubby fingers, we suggest it be lami-



nated and glued on using a thin layer of silicone sealant – or it can be printed on adhesive-backed paper.

With the label in place, the IEC connector can be snapped in. Make sure it is the correct type, designed for mounting on a 1.5mm panel, or else it will not be secure. If is it all sloppy in the cutout, we suggest a couple of dobs of suitable glue around the edges (inside) to keep it tight.

Then push the LEDs and RJ45 connectors on the main board through the front panel and lower the whole assembly into the plastic case, with the front panel in its recess.

If your case has a vent in the bottom, orient the board so that this vent is towards the front (low voltage) end. Screw the board onto the plastic risers using self-tapping screws.

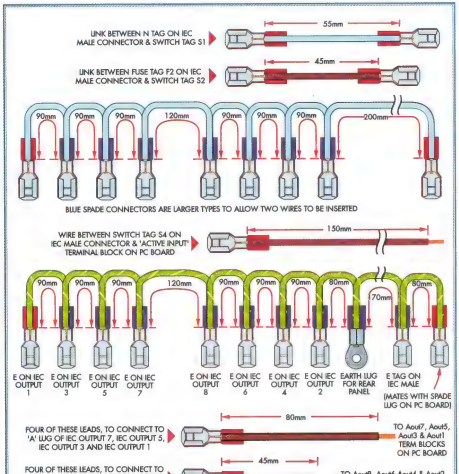


Fig.7: you'll need to make up a set of cables with spade connectors, as shown, to complete wiring the slave unit. Both the cables and spade connector sleeves should be the same colours as shown here to ensure there are no mixups between active, neutral and earth wires. (The blue sleeves allow for two wires).

Now prepare the rear panel. If you are building the module from a kit, the rear panel may be supplied pre-cut. Otherwise, cut a piece of 2mm thick aluminium (or 1mm steel) to shape as shown in Fig.9. The eight cut-outs are best made using a nibbling tool.

To accurately nibble the cut-outs, print or photocopy the template, glue it to the panel (spray glue is ideal) and nibble out the holes to the lines on the template. Use a file to clean up the holes and remove any burrs. At the same time, drill the seventeen holes and de-burr them with a larger drill.

Once everything fits, peel off the temporary label and clean with solvent (metho) if necessary. Then install the eight connectors using 10mm M3 machine screws, shakeproof washers and nuts.

You may have noticed that we used snap-in female IEC connectors in our prototype but specified screw-mount types in the part list.

This is because the snap-in connectors can easily fall out when used on a panel this thick (necessary due to the amount of metal removed for the connectors). Screw-mounted IEC connectors are much safer in this application.

Now cut 250VAC-rated wire to length and attach crimp connectors as shown in Fig.7. To ensure the wires can not come loose, you must use a ratchet-type crimping tool.

Be sure to use the connectors with the correct colour, as shown, since they are designed for different thicknesses of wire (the blue connectors are designed for thicker wire so are suitable for joining two smaller diameter wires).

Complete the slave module wiring using Fig.8 as a guide.

You may need to bend some of the spade terminals on the IEC connectors upwards to get the wires past the inductors. If so, bend them carefully using pliers, to the minimum extent possible, so that the insulated connectors still cover the exposed metal. Be sure to plug the connectors in all the way so they can't come loose.

The rear panel earth lug is attached using a 10mm M3 screw. Pass it through from the rear then place a shakeproof washer on the shaft, then the eyelet lug, another shakeproof washer and two nuts which are tightened very firmly.

If there is any coating on the rear panel, it must be scraped away around

Notes and Errata from Part 1:

We have produced an alternative PC board for the master module to suit the Jaycar PS0024 surface mount memory card socket, coded 16110103. It can be downloaded from the SILICON CHIP web site.

Also, the parts list published last month omitted the following parts:

1 28-pin DIP socket
1 mini TO-220 heatsink (Jaycar HH8502, Altronics H0630)
2 6mm M3 machine screws
2 M3 shakeproof washers
2 M3 nuts

It is a good idea to use a socket for the microcontroller in case it needs to be removed for re-programming.

Regarding the RJ45 sockets specified, there are several sockets with similar pin configurations that should theoretically work but we have not tested them.

While the ones we specified are "Type II" (ie, the pins are at the top), "Type I" (with the pins at the bottom) should also work as long as you use the same type on all the modules.

We have only tested the connectors specified in the parts list so if in doubt, stick with those.

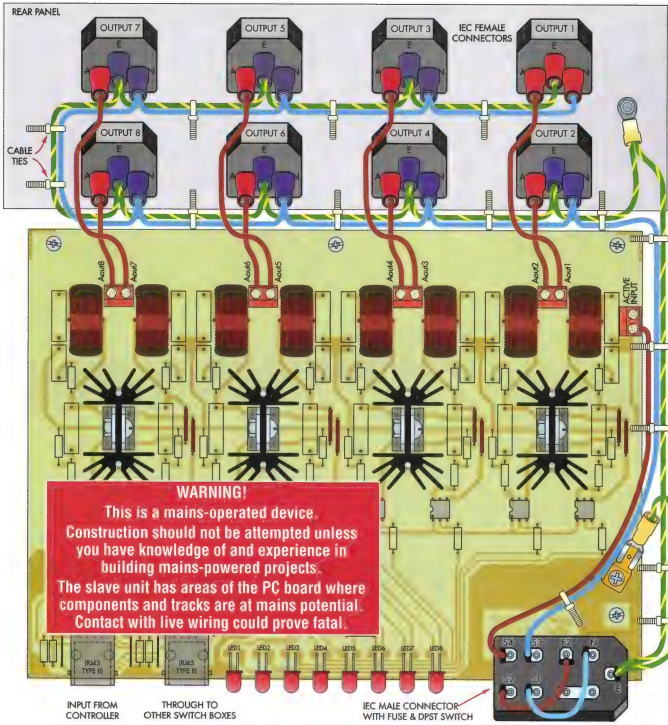


Fig.8: using the cables made up to suit (see Fig.7) here's how to wire the slave unit. It's easy if you make the cables the right lengths and terminate them with spade lugs, as shown.

the earth lug hole to ensure a good electrical contact.

Use cable ties to secure the wires so that they are held away from the components on the board and to prevent any wires from moving around and working their way loose. The lid can then be installed using the supplied machine screws.

Finally, insert the two 10A fuses into the mains input connector (15A for 115V mains). One is a spare.

Final test

First, a warning. ***Never plug the slave module into the mains without the lid in place.***

If you ever need to remove the lid, unplug the module first and before re-installing it, check that the mains wiring is secure and safe.

The whole project can now be tested. Use the same files on the memory card and the same set-up as previously but this time connect some lights.

For testing (which involves phase control), use 230V incandescent lamps only, not LEDs with a switch-mode supply. While it is unlikely that a switch-mode supply would be damaged by a brief period of phase control, it certainly won't like it!

Later, in use, LEDs with switch-

Remote control

The default remote control codes for the master unit are set up initially for a Jaycar AR1726 (TV code 102) or Altronics A1012 (TV code 156) universal remote. We explain later how to customise the codes for other remotes. These are the available functions:

Button	Command	Description
Play	play	Starts or resumes playback.
Stop	stop	Stops playback. Pressing it twice will go back to the first file.
Pause	pause	Pauses or resumes playback.
Channel +	next	Goes to the next sequence/WAV file.
Channel -	prev	Goes to the previous sequence/ WAV file.
Volume +	volup	Increase audio volume.
Volume -	voldn	Decrease audio volume.
Fast forward	forward	Skip ahead 10 seconds.
Rewind	back	Skip backwards 10 seconds.
1-9, 0	1, 2,...10	Jumps to the first, second, third etc sequence/WAV file on the card and starts it immediately. Playback will stop when it finishes.
Power	reset	Stops playback and goes back to the first file.
Record	order	Changes the playback order in this sequence: sorted, shuffle, directory, sorted. . .

See "Configuration" for more details.

Error flash codes

If something goes wrong, the master module flashes its LED in a pattern. This pattern involves a specific number of slow and fast flashes which repeat after a delay. To determine what has gone wrong, count the flashes and then look them up in the following tables:

No of Slow flashes	When error occurred
1	While re-programming the main program
2	While re-programming the bootloader
3	During operation (in the main program)

No of Fast flashes	Meaning
1	Failed to initialise memory card after 3 attempts
2	FAT file system not recognised
3	Could not find root directory
4	Re-programming completed but verify failed
5	HEX file read error
6	HEX file format invalid
7	Failed to detect valid mains frequency
8	Unexpected error while re-flashing bootloader
9	Memory card indicates wrong supply voltage
10	Memory card command time out
11	Configuration file contains invalid line(s)
12	No sequences found on memory card
13	Invalid WAV file on memory card
14	Unsupported WAV file format detected
15	Memory card file read error

mode supplies may be switched on and off using this sequencer but should never be dimmed or faded.

Join the master and slave modules together, plug the slave module into mains and switch it on. Then apply power to the master module and check that the lights operate as expected.

Using the controller

While the photo last month shows the master module sitting on top of the slave module, in practice it is a good idea to separate them by at least 50cm and if possible, run them from separate mains outlets.

The reason is that the 100Hz/120Hz Triac switching generates a fairly significant amount of EMI (electromagnetic interference).

The LC filter at each output reduces but does not eliminate the radiation. Most of the emissions are from the cabling between the controller and the lights.

As a result, if the master module is too close to a slave module then a buzzing sound can be coupled into the audio output. By keeping the modules physically separated and also separating the mains wiring this effect is minimised.

Creating sequences

In order to create a truly spectacular light show you need to make a sequence for each piece of music.

We have supplied a sample sequence along with a public domain Christmas song which you can download from the SILICON CHIP website.

To create your own sequence you will need to download and install our Windows sequencing software.

The first step in creating a sequence is to open a WAV file. Select the File->New command and you will be prompted to select the WAV file. At this point blank sequence is created.

From top to bottom, the application window is separated into the following sections: menu, toolbar, audio display, sequence display and light status bar. The menus give you access to all functions while the toolbar provides more convenient access to the most commonly used function.

Move the mouse over a toolbar button and leave it there to display a "tooltip" which explains what that button does. Buttons which can not be used are "greyed out" and in this case the tooltip will explain why. The tooltips also indicate the shortcut key combination (if available) to activate that function.

Below the toolbar is a representation of the WAV audio data, shown as it would be on an oscilloscope. If you place the mouse cursor over that section, the scroll wheel (or menu/ toolbar functions) can zoom in and out. Right-clicking or right-dragging the mouse will scroll the display, as will moving the scrollbar at the bottom of the window.

You can get a feel for how the audio display works by pressing the "play

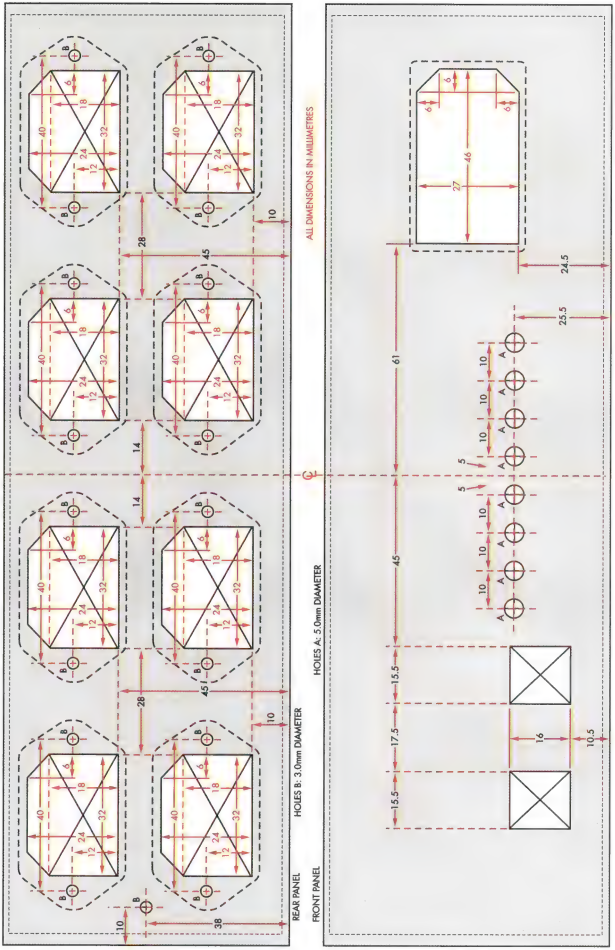


Fig.9: same-size diagrams show the cutouts and holes required for the rear panel (left) – all IEC connectors, and the front panel (right) with cutouts for the RJ45 plugs, the IEC mains connector/ fuseholder/ switch and holes for eight LEDs.

Configuration

The master module's default behaviour should be adequate for most users. You just need to load your music and sequence files onto the memory card, plug it in and switch it on.

However, some users may want to alter the master unit's behaviour. To do so, place a text file in the root directory of the memory card and rename it to "Light Controller.cfg". In Windows, it can be edited by opening Notepad and dragging this file into the main window.

In this file, each option is written on a separate line, with the option name on the left, then an equals sign ("="), then the value for that option. The possible options are as follows, with the default shown in ***bold italics***:

start playback automatically = ***yes***, no	If yes, the first file on the card is played immediately. Otherwise playback must be started via the remote control.
start file = "filename"	If set, the file of the name specified will be the first played. Otherwise the first file found is used.
default file order = ***sorted***, shuffle, directory	If set to sorted, files will be played in alphabetical order. If set to shuffle, files will be played in a randomised order. Otherwise, files will be played in the order that they are stored.
default volume = ***100%***	Allows you to reduce the initial volume. It is better to use an external volume control if possible.
default repeat all = ***yes***, no	If set to yes, when the last file finishes playback will start again at the first. Otherwise playback will stop.
filament preheat amount = ***20***	The fraction of full power to use for the filament preheat. It is a number between 0 and 255, where 255 means full power. The default should suit most incandescent lamps.
filament preheat <slave> = ***yes***, no	Controls filament preheating on a per-slave basis. <slave> is replaced with the slave number between 1 and 4. Slave 1 is the slave closest to the master module.
filament preheat <slave>:<channel> = ***yes***, no	Controls filament preheating on a per-light basis. <channel> is replaced with the channel number between 1 and 8.
triac turnoff <slave> = ***immediate***, delayed	If set to delayed, the trigger pulses for the specified slave will be held until the end of each mains half cycle. Read the section on delayed turnoff before using this option.
triac turnoff <slave>:<channel> = ***immediate***, delayed	As above but allows control on a per-channel basis.
remote code <command> = ***RC5***(0x????) or NEC(0x????)	Allows the unit to be configured for different remote controls. See "remote control configuration" for more information.
infrared logging = ***off***, on	If set to on, the unit will log all infrared activity to a file. This assists with reconfiguring the codes.

Here is an example configuration file:

```
default file order = shuffle
filament preheat 1:7 = off
filament preheat 1:8 = off
triac turnoff 1:3 = delayed
triac turnoff 1:4 = delayed
```

file" button with speakers or headphones connected to the computer.

Below the audio data display are the sequencer light states, which scroll together with it.

The brightness of each horizontal strip represents the brightness of the light as time passes. By clicking on a portion of the audio data, you can see state of the lights at that point in the sequence on the light status bar, at the bottom of the window.

This bar is also active during playback to provide a preview of the sequence.

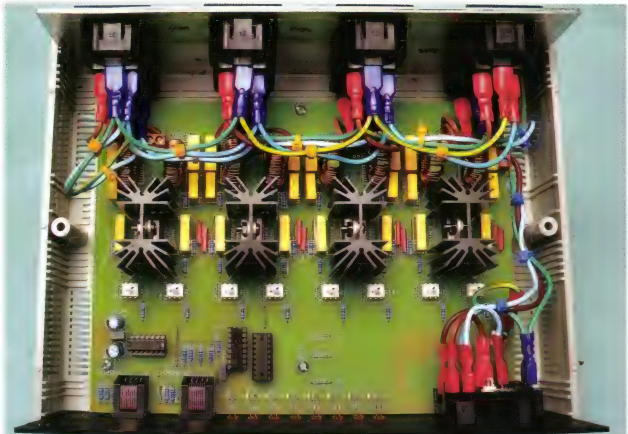
Manipulating the sequence

Click and drag the mouse within the sequence area to select a portion, which will turn blue. You can move the start and end of the selection by dragging them. It is also possible to select from the audio display.

Which lights are selected can be changed by clicking on the light names at the left of the window. Control-click and shift-click allow you to select multiple lights.

Once a selection has been made, you can manipulate that portion of the sequence using the functions towards the right-hand side of the toolbar (or from the Lights menu).

These include turning the light(s) on or off for that period, setting them to an intermediate brightness, ramping the brightness up or down or performing a "cascade" where the lights are turned on in sequence.



Inside the completed slave unit – this shows push-fit IEC connectors on the rear panel but with 20:20 hindsight, we now recommend captive types (with screws and nuts). For safety, follow our wiring diagrams and photos exactly!

The best way to understand how these functions work is to experiment with them. After changing the sequence, you can play it (or a section of it) to get an idea of what it will look like.

The easiest way to do this is to select the section of the file you are working on and press the "set play region" button on the toolbar. You can then use the "Play region" function to play this section at any time as you are working on it.

If you make a change that you are not happy with, simply use the "undo" function to revert it.

Auto sequencing

For automated sequence creation there is the "beat detection" function which pulses one or more lights in time with the beat, the "spectrum analysis" function which behaves like a "Musicolour" and even an "automatic sequencing" function which can generate a complete sequence with just a few mouse clicks.

The GUI (Graphical User Interface) is designed to be easy to learn so with a little experimentation you should be able to figure out most of its functions. We don't have enough room for a more detailed explanation this month but we will provide more information next month.

Delayed turnoff

The delayed turnoff option should only be used in two situations – either during testing, to allow the slave indicator LEDs to vary their brightness or else for channels with lights that have insufficient current to properly latch the Triacs (<25W or so). If the brightness of your lights is not being properly controlled, you may need to use this option.

In the latter case, only enable delayed turnoff for the affected channels. It is not a good idea to have more than a few such channels as this results in higher current drain on the 6V line. This can cause excessive heat generation in the 7806 regulator and higher voltage drops across long Cat5 cables, possibly resulting in incorrect operation.

Ideally, use lights with a high enough power to allow the Triacs to latch.

Remote control configuration

Up to three remote control codes can be assigned to each command. These can be Philips RC5 12-bit codes or NEC 16-bit codes (used by some Digitech remote controls). Either way, the code is specified as a 4-digit hexadecimal number.

Do not worry about what this means as the infrared logging feature can tell you what codes your remote control uses. Simply enable the feature, turn the unit on and press the buttons you are interested in. All you then need to do then is open the log file on your computer, copy the codes into the configuration file as appropriate, and disable the logging feature.

The format for an RC5 code is "RC5(0x1234)" and for an NEC code it is "NEC(0x1234)". For example, to configure the master module so that RC5 code 0x0020 triggers the "next" command (which is the default), add the following line to the configuration file:

```
remote code next = RC5(0x0020)
```

To add two to four possible remote codes for a given command, separate them with commas.

SERVICEMAN'S LOG

Do-it yourself servicing at the deep end

It's quite common to hear people complain that they spend more time maintaining their swimming pool than they do swimming in it. It's not just a matter of keeping the water clean – you have to maintain the pump and electronic control gear as well.

Items Covered This Month

- Swimming pool pump controller & thermostat monitor
- BWD 207b power supply
- The 5-minute PC fix – not

My first story this month comes from R. W. of Noosaville in Qld and concerns a number of interesting faults in his swimming pool control gear. I'll let him tell it in his own words . . .

This saga covers a period of about eight years to the present. It all began when we moved into a 12-month-old house and had a pool installed.

To save me the chore of buying and decanting chlorine, we opted for a saltwater pool with a cell to generate the chlorine. We also opted for solar heating, as we hoped to swim for most of the year.

Things went well for about 10 months, then occasionally the pool pump would not start in the morning. The obvious "fix" was soon discovered – give it a gentle thump on the side of the control box and it would immediately spring into life!

However, with the 12-month warranty on the unit nearly up, we soon decided that thumping it was not the best answer and that it should be properly fixed. And so it was left with the local agent for a 100km round trip to the depot. They were very efficient because just four days later, the agent rang to say "it's fixed, come and get it".

When we went to retrieve it, we asked what the problem was but this only brought a blank stare from the lass in the pool shop. Oh well, if it's fixed, why should we care.

Anyway, we re-installed the control box and all worked well for a couple of weeks. Then the intermittent fault returned. This time, having spent 25 years of my life as a service technician, I thought "what the heck – I can fix a simple thing like a pool pump controller".

Disconnecting the control box from the motor, flow sensor and mains didn't take long but clearing a place on the workbench took much more time. I then removed a couple of screws and the cover lifted off. It was nicely made, with a screened PC board, well laid out parts and rugged clip-on connectors.

Now what is the most common cause of intermittents that can be cured with a gentle tap? Yes, dry joints of course. There were none on the flow-soldered PC board but it was a different story when it came to the power transformer (a rather large PC-mount unit). The mains side was fine but the heavy secondary pins all had dry joints.

The solder joints themselves looked good but the solder had not adhered properly to the pins. I sucked the old solder away, gave the pins a good scrape with a sharp knife and carefully tinned them before resoldering them to the PC board.

The chlorinator cell takes quite a few amps at around 16V and the pool pump is controlled by an AC relay. By now, it was obvious that the problem was fixed (famous last words!) and with it all back together, it was running like a bought one.

This time, there were no more worries for a couple of years but then the control buttons became progressively less responsive. There are nine buttons in all and these are covered by a flexible membrane to keep the hostile salt atmosphere away from the PC boards. One is the on-off control button, another steps the level of chlorine injection and a third carries out a super-chlorination cycle. The remaining six buttons are for the time and day settings.

The pressure required to actuate these pushbuttons gradually increased until one day, I pressed so hard that the membrane split. Fortunately, I found a local technician who serviced all brands of chlorinators and he sold me a new membrane. He also told me that he thought the switches were unobtainable and offered a replacement PC board for around $350.

A quick check through a few catalogs soon revealed that Jaycar had the switch as a stock item. Replacing both the switches and membrane then restored the unit to full health.

The pool is cold

A few more years passed, then one day my wife complained that the pool was "cold". A quick check with a

Servicing Stories Wanted

Do you have any good servicing stories that you would like to share in *The Serviceman* column in SILICON CHIP? If so, why not send those stories in to us? In doesn't matter what the story is about as long as it's in some way related to the electronics or electrical industries, to computers or even to car electronics.

We pay for all contributions published but please note that your material must be original. Send your contribution by email to: editor@siliconchip.com.au

thermometer revealed that the water temperature was only 23° instead of the set 25°. The cure was simple – just turn the preset to 27° and all was well, except that as the months went by the setting had to be progressively increased until it was finally at its maximum of 39° in order to set the pool at 25°.

You can put these tasks off for so long but eventually you have to take the plunge (pun intended). And so the solar control box was disconnected and opened up on my workbench.

Of course, this was a new "black box" and I had no idea what the circuit was really like. However, in view of its function, it had to use a comparator of some sort plus a thermocouple or similar to monitor the pool temperature. The pool temperature reading would then be compared with the stored reading set by the front-panel pushbutton. In operation, the solar pump ran until the pool temperature reached the preset, then the pump turned off.

The first step was to simulate the pool sensor which turned out to be a thermistor. I heated some water to 25° and inserted the pool sensor in it, then read its resistance. This value then became my reference.

Of course, Murphy now reared his ugly head and the controller switched off when the indicator showed 26°, ie, it was suddenly working correctly.

No amount of prodding or poking could provoke the fault. As a result, I made a number of voltage checks and then left it running overnight (it was the middle of winter). Fortunately, by next morning, the fault had reappeared so I repeated the voltage checks.

The reference voltage is derived from a zener diode (the zener voltage was the same as previously) and this is then fed through a resistor to a potentiometer, which is used as the calibration adjustment. The voltage on the wiper had dropped so that was my clue.

The resistor value was checked and found to be spot on so I moved onto the pot. In the end, the culprit turned out to be the crimped connection at the end of the potentiometer – it was going slightly high in resistance. In all my years of servicing, I have never struck this type of fault but there's a first time for everything I guess. A new preset control solved the fault.

350/250/150MHz Digital Storage Oscilloscope **GDS-3000 Series**

With 5GSa/s sampling and VPO technology (Visual Persistence Oscilloscope) , GDS-3000 Series displays waveforms truthfully and captures less-frequently-occurred signals , like glitches or runts , simultaneously without missing any spot of waveform information.

- 5GSa/s Real-Time Sampling Rate and 100GSa/s Equivalent Time Sampling Rate
- Unique Split Screen Display with Independent Setting for Each Input Channel
- Optional Power Measurement Software
- Optional Serial BUS Trigger and Decode Software Supporting I^2C , SPI and UART

EMONA
T 1 800 632 953 mail: testinst@emona.com.au
www.emona.com.au

GW INSTEK
GOOD WILL INSTRUMENT CO., LTD.
www.gwinstek.com

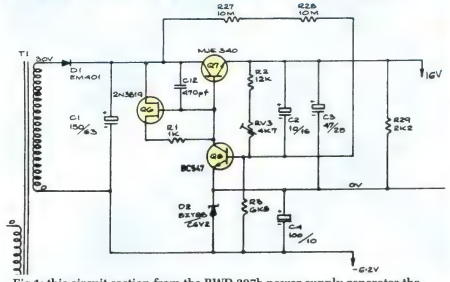


Fig.1: this circuit section from the BWD 207b power supply generates the +16V and -6.2V reference voltages. This is done using zener diode D2 and an error amplifier based on two bipolar transistors and a JFET.

With the rapidly increasing cost of electricity, my next project is to eliminate the solar pump motor. The pool pump label says "1.5 horsepower" while the solar pump label says 1kW (1.25hp).

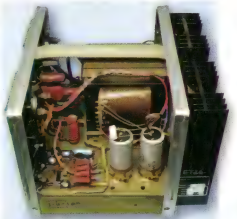
Basically, the job will involve fitting a valve to divert the pool pump flow from its normal path to the pool, feeding it instead up to the solar collector on the roof whenever the pool temperature is low. When I get my next power bill the incentive will probably be there. Until then, inertia will probably rule the day.

BWD power supply

This next story comes from SILICON CHIP staff member Nicholas Vinen and concerns a BWD model 207b DC power supply that was originally purchased by "Electronics Today" in 1972. SILICON CHIP subsequently purchased it from "Electronics Australia" when that magazine ceased publication some 10 years ago.

This supply is a linear DC type with an output voltage of 10-15V at 12A or 20-30V at 6A (with internal foldback limiting). And as you would suspect from these figures, it is a large and heavy unit, primarily due to the size of the transformer but also the substantial steel chassis. It has 16,000µF worth of filter capacitors for its unregulated supply and an 8000µF filter on the output.

Back then (ie, in 1972), ICs were not as common or as cheap as they are today, so the regulator circuit consists



This is the view inside the BWD 207b power supply. It's based mainly on discrete components.

mainly of discrete components. In fact, the only IC used is a CA3046 transistor array which was manufactured in Australia by AWA. This is used in the two main error amplifiers, as its transistors are well-matched. There are also a number of discrete transistors, all NPN types as PNP types at that time were substantially more expensive and didn't work as well.

The supply's output voltage is regulated by four 2N3055 transistors in TO-3 packages which are mounted on large heatsinks at the rear of the chassis. The transistors themselves are covered with plastic insulators so that the user can't get a shock from touching the metal bodies.

As an aside, the supply was manufactured by BWD in Victoria, who also manufactured the transformer and chassis (the two most expensive parts). Many of the other components were produced in Australia as well. For example, the meter movements were made in Sydney by Master Instruments, while the main voltage adjust-

cleverscope
Mixed Signal Oscilloscope
+ Signal Generator
Some key features
+ Windows and Linux
+ 10ns resolution on 40 msec display
+ Disk save at 1.5 MSPS, to 500 GSamples.
+ Spectrum analysis – see 50Hz in 50 MHz.
+ Driver software for Visual C#, C++, Basic, Labview, Delphi and C Builder with examples.
+ Protocol decoding – SPI, I2C and UART
+ Isolated Ethernet option
Mixed signal with protocol decoding
www.cleverscope.com

ment potentiometer (a wirewound type) was made by A. C. Naunton & Co, Victoria.

This particular unit had not been used for many years. And then one day we had a need for a high-current DC supply, so we switched it on. The red power lamp at the front lit up but the voltmeter did not move off its zero mark. Attaching a multimeter to the outputs confirmed that the supply was not delivering any output voltage.

After removing the cover we checked the voltage across the large DC filter capacitors and confirmed that the expected voltage, about 26V DC at the lower output setting, was present. We also checked the voltage at the adjustment potentiometer terminals but it was more or less zero. So the fault was likely to be somewhere on the small control board and not in the output transistors.

Since we had no service manual or circuit we put the supply aside and placed a notice in the magazine asking for the manual. Before long we had several responses from helpful readers who sent us service manuals in various forms; one original manual, one photocopy and a scanned version.

The circuit diagram, which we have partially reproduced here (Fig.1), gave some important clues as to the fault. This section is responsible for generating two reference voltages relative to the positive output terminal, ie, -6.2V and +16V. Both are generated from an auxiliary 30V secondary winding on the mains transformer.

The -6.2V rail is regulated by a zener diode and is bootstrapped from the +16V rail. The +16V rail is regulated by a transistor-based linear amplifier using the -6.2V rail as a reference. This amplifier comprises transistors Q6, Q7 & Q8. The problem with the supply was in this reference circuit, as the -6.2V rail measured -0.6V and the +16V rail measured 0V.

The first possibility was that either the 6.2V zener diode or its parallel 100µF capacitor could have failed short circuit but after removal both tested fine, so they were re-installed. In fact, the 100µF capacitor measured 162µF despite being nearly 40 years old, while the zener diode was spot on.

Our next step was to temporarily unplug the CA3046 transistor array IC in order to rule out the possibility that the -6.2V rail was being pulled up by a fault inside this chip. That did not have any effect on the reference voltage which meant that the fault was clearly in the reference circuit itself and so the IC was reinstalled.

The fact that the 16V rail bootstraps the current supply for the 6.2V zener complicates troubleshooting this circuit. It seemed like the zener was not getting any current but without the zener voltage, the +16V rail would not operate correctly anyway. Resistor R29 (2.2kΩ) which feeds current to the zener measured OK.

To work out what was going on we checked the voltage across R1 to confirm that FET Q6 was supplying current to Q8's base. This read about 2.2V, indicating a 2.2mA current flow, ruling out Q6 as the faulty party. Q8's V_{BE} measured around 0.65V so it seemed to be OK too, but Q7 remained off.

The only remaining components that could be at fault were R2 and RV3 (which form the resistive divider for the amplifier feedback), capacitor C2 which bypasses the divider and capacitor C3 which filters the +16V rail. R2 and RV3 did not measure as short circuit so it

RFID Security System

Here's a high-security system that's very easy to build but offers you peace-of-mind for your home, car – in fact, anything where entry needs allow the good guys in but reject the bad guys. Team it with an electric lock and you can have a keyless entry system as well!

It's a sad fact that in today's world the need for property security is ever present. Our homes and business properties are a target for thieves and other criminals.

We spend countless amounts of money on systems that have been designed to counter the would-be bad guys.

The complexity of these systems ranges from a simple sticker that proclaims Batman will jump through the window and zap any burglar stupid enough to attempt robbing the premises, all the way up to computer controlled alarms systems that use satellites to protect our property and warn of a crime in progress.

Although the system presented here does not quite communicate with satellites it will give a high level of protection and control access to any structure that it is monitoring.

RFID?

If you have an E-tag for the tollway, a micro-chipped pet or a late-model car with an immobiliser key, then you're already using radio frequency identification (RFID) technology. Although RFID is not a new field and it has been written about in this magazine in the past, it is now available as a project for any person who wants to protect their property from unauthorised access.

This system will give control over who has access to your home, car or any other building you care to mention. The system is installed in a position that will allow the users access to the protected building.

A tiny (keyring-sized) RFID tag is held close to the sensor. The system detects the tag and compares its "signature" with those stored in memory (up to eight).

If, and only if, a match is found, an on-board relay is enabled for one second. This relay could be used to disarm a burglar alarm or unlock a door.

If the detected tag is not one of those stored in memory then the system can be used to trigger an alarm or to sound a warning that an unauthorised access has been attempted.

The advantage of this is that tags can be changed and the system re-programmed at will, so if a tag is stolen or even if someone attempts entry who is no longer allowed, that tag will have no effect except to flag an unauthorised entry attempt.

The operating principals of RFID were explained in a previous article (July 2003) so if you want to know how the system works in detail you should read that article. Copies are available from SILICON CHIP.

Basically, RFID operates by generating a magnetic field then looking for any modulation on that field. RFID "tags", when bought within range of the scanning coil will send out a unique series of bits.

The on-board microprocessor decodes these bits and outputs a data frame from pin 1 which is sent to RB0 (pin 6) of IC2.

The range of this system is around 4cm which, although not a lot, is ideal for

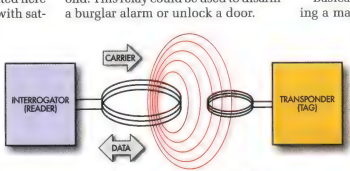
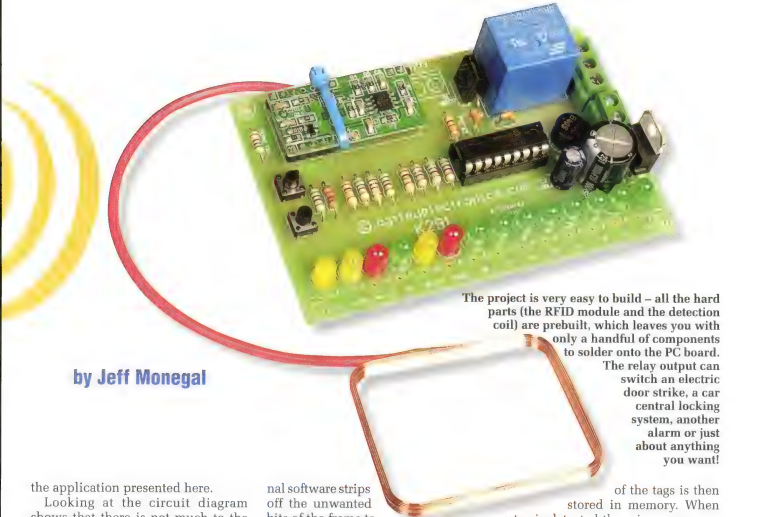


Fig.1: a basic RFID setup consists of a reader (or interrogator) and transponder. Low frequency systems rely on inductive coupling to provide transponder power.



The project is very easy to build – all the hard parts (the RFID module and the detection coil) are prebuilt, which leaves you with only a handful of components to solder onto the PC board. The relay output can switch an electric door strike, a car central locking system, another alarm or just about anything you want!

by Jeff Monegal

the application presented here.

Looking at the circuit diagram shows that there is not much to the system at all. The RFID part consists of a pre-built module that generates the necessary RF field used to scan the tags as they are bought within range of the scanning or detection coil.

As well as "reading" the data from the tag, the coil also provides power to the tag via inductive coupling. It's a minute amount of power but enough to "wake up" the tag and cause it to transmit its unique code back to the coil.

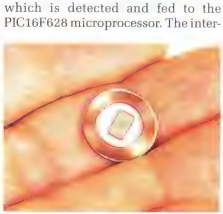
The data frame consists of 42 bits which is detected and fed to the PIC16F628 microprocessor. The internal software strips off the unwanted bits of the frame to leave the last 24.

If you think that this cuts down on the number of different combinations then consider this: 24 bits = 2 to the power of 24, equals 16,777,216.

The circumference of Earth is 40075km... If you think of Earth as a giant chocolate wheel you would need a pin spacing of 2.4 meters around the full circumference of the wheel to equal this number of bit combinations.

Another way of looking at it is, if each tag is randomly programmed when manufactured, you could line up 24 people and get each one to toss a coin, "1" for heads "0" for tails... the chance of one of the combinations being repeated again is one in 16,777,216... If the coins are tossed once every minute the probability of repeating the same combination again would take 32 years...

I think you will agree that 24 bits are more than enough to ensure good security for this project!



The "works" of the RFID tag is tiny, as this photo shows. Very close to actual size, this is the same tag that's encased on the keyring shown above left.

Up to eight tags

When setting up the system the user can make the system learn up to eight separate tags. The unique code of each of the tags is then stored in memory. When a tag is detected the micro compares its code with those in memory. If a match is found the relay is latched for one second and the GO led is lit also for one second. One of the eight user LEDs will also light to indicate which tag was detected.

After the relay unlatches, the system goes back to standby, waiting for the next tag to come by. That is really all there is to the system. The relay can be used to operate an electric door strike to give controlled access to a room or building.

Be careful when selecting the strike: you can get "fail safe" where the lock

The heart of the project is this RFID module, which comes pre-assembled and tested, ready to solder into the PC board.

Pressing the USER SELECT button will cause the user LEDs to cycle around. First press will turn user 1 LED off and user 2 LED on. Next press will turn user 2 LED off and user 3 LED on. Each press of the select button will shift along the LEDs. When LED 8 comes on the next press will cycle back to user 1 LED.

When you are happy with the memory location press the learn button again. The last decoded tag will now be stored in the memory location indicated by the user LEDs. The LEARN LED will now flash once. The program now stores the unique tag ID in EEPROM.

That's it, the tag has been saved. When the same tag is decoded next time the system will respond and allow access to the user holding that tag.

To erase any memory location the operator simply goes through the same procedure and stores the new tag over the top of what was stored in the old memory location.

To summarise the tag learning procedure users should consult the following table:

ACTION	RESULT
Press and then release the LEARN button	Learn LED on
Bring required RFID tag in range of coil	Learn LED off User 1 LED on
Select memory location with SELECT button	User LEDs shift along
When location selected press LEARN button	Tag stored in user location

The Tag has now been detected, decoded and stored in the User EEPROM location.

Construction

Assembly of the project is fairly straightforward. The PC board is of a very high quality so as long as your soldering is up to the task and the components are placed in the correct position you are virtually assured of an operational project.

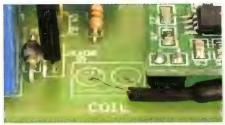
Start with the resistors and capacitors. Remember that the electroylitic capacitors are polarised so be careful when installing them. The same goes for the LEDs.

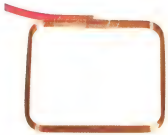
There is a trap for young players with the LEDs: all bar one mount flat side (cathode) to the right, when looking at the board with the terminal blocks on the right. LED 14 mounts cathode to the left. You have been warned!

It is recommended that an IC socket be used for the microprocessor – again, this must go in the right way around.

The RFID module should be installed next and again be careful when handling this component.

The bridge rectifier, 3-terminal regulator and transistor are next and all three are polarised (no heatsink is needed on the regulator). The relay is the last on-board component and will only go in one way.





The sensing coil (shown close-up at right) solders directly to the PC board alongside the RFID module. This coil, which measures about 50 x 45mm, is made from very fine wire so needs to be treated with all due care. The ends of the coil wires pass through a protective spaghetti sleeve to protect them.

Sensing coil

The sensing coil is supplied preassembled, which means you only need to attach it to the PC board.

However, the wire which forms the coil is quite fine and will be easily damaged with any form of rough handling. There's about 200mm of wire emerging from the coil – this attaches to the two points marked "COIL" on the PC board (polarity is unimportant).

To protect this fine wire, we slid on a piece of thin heatshrink tubing over the two wires (which are in fact loosely twisted together) and glued it to the coil itself (the coil is actually quite rigid).

To prevent stress on the opposite ends of these wires (ie, the end where they solder to the PC board), we anchored the heatshrink with a small cable tie right around the RFID module and heatshrink

You also need to decide whether you're going to have the coil close to the PC board or some distance away.

If you mount it any further away than the ~200mm allowed by the connecting wires, you'll need to extend them with either thin insulated hookup wire or better still, two strands of ribbon cable or some thin Figure-8 cable.

Note that we have not tested the RFID unit with the coil any further away than the 200mm. In theory, it should be quite OK but . . .

Smoke test

At this stage do not install the microprocessor. Apply power and using your multimeter measure the voltage on pin 14 with respect to pin 5 of the micro. You should read close to 5V DC. If OK, then switch off the power, wait for a short while and then install the microprocessor.

This time when you switch on the power the LEARN led should come on for 500ms.

If this happens then the system is alive and well and ready for work.

One of the first things the program does is to load the eight user IDs from EEPROM so it is ready to decode the stored tags.

If no user data has been stored in EEPROM the unit will ignore all tags. Go through the learning tag procedure to store at least one tag. SC

ELNEC IC PROGRAMMERS

High quality
Realistic prices
Free software updates
Large range of adaptors
Windows 95/98/Me/NT/2k/XP

CLEVERSCOPE USB OSCILLOSCOPES

2 x 100MSa/s 10bit inputs + trigger
100MHz bandwidth
8 x digital inputs
4M samples/input
Sig-gen + spectrum analyser
Windows 98/Me/NT/2k/XP

IMAGECRAFT C COMPILERS

ANSI C compilers, Windows IDE
AVR, TMS430, ARM7/ARM9
68HC08, 68HC11, 68HC12

GRANTRONICS PTY LTD
www.grantronics.com.au

PARTY TIME AT JAYCAR

Mini 3 Channel RC Helicopter

An entry-level chopper for the first time flier. 3 channel means you don't have too many controls to think about so you'll be up and flying in no time. Robust moulded plastic construction to take the inevitable bumps and occasional crash. 20 minute charge gives about 10 minutes flying time and the chopper recharges directly from the remote unit.

- Requires 6 x AA batteries
- Measures: 160(l)mm approx
- Recommended for ages 8+

GT-3306

Spare blade set GT-3307 $9.95

$29.95

70W Universal Mains Netbook / Laptop Power Supply

Perfect for use as a replacement laptop power supply or to keep as a spare. Suitable for most laptop/netbook models. See website for compatibility.

- Output voltages: 4.2 - 24VDC
- Output voltage selection: Automatic
- 16 Plugs
- Dimensions: 110(L) x 52(W) x 25(H)mm

MP-3320

$59.95

Digital Stereo Recorder

Simple one button recording - press once for standby then again to record, or use the VOX function. It captures audio directly on built-in 2GB memory, which is ready for more than 50 hours stereo recording, and also on high capacity SD/SDHC cards. You can record at super-clean 24-bit resolution with a wider dynamic range (up to 96kHz sampling rate) with this unit, providing twice the digital audio definition of ordinary CD's. Records via the stereo pair of microphones straight to an SD card then you can also edit the recordings in the unit itself. Suitable for recording jamming sessions, conferences, meetings and lectures. Pocket size to take anywhere and can be powered by batteries or a 5VDC plugpack (not included).

- Formats: MP3, WAV
- Line in and mic inputs
- Headphone & built in speakers
- Sample rates: 16 - 96K, 16 or 24 bit
- Switchable stereo or mono • Tripod mount
- Requires 2 x AA batteries (gives 15hrs)
- Dimensions: 60(W) x 112(H) x 22(D)mm

XC-0386

$199.00

FM Transmitter with Dock for iPod®

Listen to your favourite tunes through the FM radio in your car - dock and charge your iPod® at the same time. This nifty little unit stays in your cup holder and is powered by your car's cigarette lighter outlet. It's compatible with most iPod® models, works with MP3 players, CD players and other media devices. See website for iPod® compatibility.

- Last frequency memory
- Backlit LCD
- Size: 82(Dia) x 78(H)mm

AR-1869 WAS $79.95

$49.95

SAVE $30.00

Note: iPod® not included Limited stock

JV60 6.5" 3 Way Speaker Kit

JV60 6.5" 3 Way Speaker Kits - 150WRMS

With the return of the Vifa drivers, we are proud to re-introduce the JV60 speaker kit. By investing a couple of hours of your own time to build this superb system to compliment most mid-powered amplifier/receivers, you can save hundreds over commercial speakers. Kit is sold in two parts; speaker components and mounting accessories and pre-built speaker cabinets. Both have enough components to build a pair of JV60s.

JV60 Speaker Kit with Crossovers & Accessories - Pair

- Speaker kit includes woofers, tweeters, crossovers and mounting accessories.
- 4 x 6.5" Vifa P17WJ (see CW-2106 for specs), cast magnesium basket, mineral filled polycone woofer
- 2 x Vifa D25AG (see CF-2020 for specs), aluminium alloy diaphragm, Ferro fluid cooled tweeter
- 2 x 3-way, Linkwitz-Riley filter with polyswitch protection and impedance equalisation

CS-2560 $499.00 pair

Speaker Kits are Back!

JV60 Prebuilt Cabinets - Pair

- Bass reflex design with corner frequency of 35Hz
- Pre-built with all holes cut for components
- Finished in "blackwood" veneer
- 1090(H) x 250(W) x 260(D)mm (50L internal volume)

CS-2562 $199.00 pair

$499.00

Pre-assembled JV60 Complete - Pair

We are also offering a fully assembled version if you just don't have the time but still want to experience the quality performance of this design.

CS-2564 $899.00 pair

Place your order in-store and we'll build it for you.

2MP Web Camera with Microphone

Ideal for podcasting or creating your next YouTube masterpiece. No drivers required, just plug and shoot. Built-in microphone included for adding sound.

- 720P HD Video
- Plug-and-play

QC-3237

Also available 300k Web Cam with Mic QC-3235 $19.95

$59.95

DAB+/FM Digital Radio Kit

There are very few digital radios available as hi-fi components & the few that are cost north of $700. Many hi-fi enthusiasts want to add a digital tuner to their system and want function and sound quality over bells & whistles. It covers DAB+ & FM, has analogue and optical audio outputs, IR remote (optional extra), an external antenna connector and is powered by a low-cost mains plugpack. The kit is complete with all electronic component and screen printed case. See website for full specs.

- Digital station info display
- RCA and optical audio output
- External antenna connection
- Station memory presets
- Requires mains plugpack

KC-5491 Due into Stores late November 2010

$399.00

Covert Pen Video Camera

Maxwell Smart would have loved to have one of these to go with his shoe phone. Capture video, audio or still photos discreetly and quickly, then transfer them onto your PC via USB. The built-in memory stores up to 4GB, so there's plenty of capacity for taking electronic notes at your next meeting or protecting your legal rights by capturing a video or audio record of an event. It also functions as a conventional ballpoint pen.

- One-button operation
- Recharges via USB
- Drivers included
- Resolution: 640 x 480 VGA
- Still image resolution: 8MP
- Up to 2 hours of video or 600 photos
- Size: 148(L) x 15(Dia)mm

QC-8004

$99.00

Motorised Plasma/LCD TV Brackets

With the touch of a button, swivel or tilt your LCD or plasma TV either manually or to a pre-programmed position. The mount will fit standard VESA 200, 300 or 400mm and with a specified operating noise level of 25dB, they are practically silent. Ideal for TVs that are concealed behind panels or TVs in commercial environments like pubs, clubs or conference rooms etc.

30kg Motorised TV Bracket

Projection distance: 150mm

TV weight: 10 - 30kg

CW-2835 $299.00

50kg Motorised TV Bracket

Projection distance: 180mm

TV weight: 30 - 50kg

CW-2837 $499.00

FROM $299.00

NEW Reynalla, South Australia Store

141 Sherriffs Rd
Reynella SA 5161
Ph: (08) 8387 3847

Off street parking available!

www.jaycar.com.au

To order call
1800 022 888

Prices valid until 23/11/2010. Limited stock on sale items. No rainchecks. All Savings are based on Original RRP

Jaycar Electronics
Better, More Technical

Twinkle DMX Laser Shows

Whether staging a dance club or house party, these laser light projectors help create the perfect dance floor atmosphere. They produce truly spectacular lighting effects with plenty of geometric patterns and overall effects to choose from.

$149.00 each

Two models available:

Red Twinkle DMX Laser Light Show SL-3431 $149.00
- Dimensions: 205(L) x 80(W) x 145(H) mm

Green Twinkle DMX Laser Light Show SL-3433 $149.00
- Dimensions: 205(L) x 80(W) x 145(H) mm

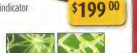
Green DMX Laser Show

Creating nightclub effects on a budget price is easy with this green laser light display. Applying the latest technology this laser projector is ideal for bars, clubs, house parties or family functions. It produces impressive lighting effects with sound activation or DMX master/slave control.

Light weight and portable at only 1.5kg; take it with you to create a magnificent laser light atmosphere.

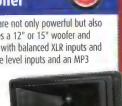
- More then 100 green patterns
- Sound activation microphone
- Sound and power active indicator
- Safety function
- Sensitivity adjustment
- Dimensions: 205(L) x 80(W) x 145(H) mm

SL-3436



$199.00

Active PA Speakers with MP3 Controller



2-way active PA speakers that are not only powerful but also extremely portable. Incorporates a 12" or 15" woofer and compression driver, 3 channels with balanced XLR inputs and 1/4 unbalanced inputs, RCA line level inputs and an MP3 controller. Ideal for DJ, PA for schools, sports, churches, weddings, conferences etc.

- SD card and USB inputs
- Tough moulded enclosure
- 2 band equaliser
- Line level RCA inputs

200W 12" Active PA Speaker with MP3 Controller CS-2529 $399.00
- Dimensions: 620(H) x 400(W) x 400(D)mm

FROM $399.00

300W 15" Active PA Speaker with MP3 Controller CS-2530 $469.00
- Dimensions: 690(H) x 460(W) x 400(D)mm

i.Scratch CD & MP3 DJ Station

No need for a laptop or PC - the i.Scratch DJ Station gives you the digital DJ essentials. Front loading CD tray, large LCD screen and an XXL jog wheel. Sample banks, cue point banks, seamless loop & reloop, instant start, auto cue, fast cue, track & folder search, pitch range/bend and scratch. CD, CD-R, CD-RW, MP3 compatible.

- S/PDIF digital audio & RCA coaxial outputs
- Fully programmable repeat function
- Fader start & relay mode
- Measures: 348 (L) x 246(W) x 106(H)mm

AA-0493
WAS $349.00

Buy 2 For Only $499 Save an extra $99.00

$299.00
SAVE $50.00

Green Laser Star Projector

Projects thousands of dazzling green laser star like formations and comes with an integrated amplified speaker to connect an iPod® and MP3s to blast tunes through the stars. To complete the ambience, it also has colour changing LEDs which can be set to beat with the music or one of the four colours (red, green, blue and white).

- De-stress speaker
- 6W Motion light
- HDSS noise filter technology
- Dimensions: 140(L) x 140(H) x 110(D)mm

SL-2931

$149.95

12VDC 5W Mono Amplifier - Bargain

Sometimes you don't need gigawatts and multi channels and this versatile small audio amp is excellent for the workshop, test lab, as a small PA or for busking.

Includes RCA and microphone inputs, dual speaker outputs. Runs on 12VDC input so you can run it from a battery. Please note that this amp has dual inputs and outputs but is mono.

- Power output: 5WRMS
- Short circuit and thermal protection
- Dimensions: 190(L) x 170(W) x 85(H)mm

AA-0483 May not be available in all Stores - call to check!

$14.95

DJ Skills Mixing and Scratching Guide

Explores the history of the DJ from the radio jock to the hip-hop, rave and club generation, and the influence of jazz and other music forms on the modern DJ. It also covers tools of the trade - turntables, hard disks, drum machines, effects and mixers, as well as the skills to become a working DJ.

- Softcover, 282 pages, 240 x 190mm.

BA-1445

$44.95

Mini Strobe Light

Great for parties! Features a variable flash rate up to 10Hz, and is mains powered. Uses a Xenon flash tube. The unit is housed in a compact case measuring 85(W) x 50(H) x 125(D)mm and is fitted with an adjustable mounting bracket.

SL-2990
WAS $34.95

$24.95
SAVE $10.00

2 Channel Pro DJ Mixer

The ideal mixer to learn on. Two channels each with RCA inputs for CD or other line level source and a set of dedicated phono inputs. The BPM counter is capable of accurately measuring the beats per minute of almost any kind of dance music automatically and works equally well with a CD player or a turntable.

- Level meters on each channel
- 2 band EQ on each channel
- Phono and line level inputs
- Mic and headphone outputs
- Effects loop
- Line level preamp outputs
- Selectable CF curve
- Dimensions: 330(W) x 22(H) x 102(D)mm

AM-4206

$149.00

Party Light Set

Get your party started the right way with these creative lighting effects!

Party pack contains:
- 20cm (8") mirror ball
- Mirror ball motor (240VAC) 3 RPM
- PAR 36 spotlight (240VAC)
- 4 x coloured filters for spotlight (colours: red, amber, green and blue)

SL-2978 WAS $84.95

$69.95
SAVE $15.00

USB Turntable with USB Direct Encoding

Transfer your vinyl collection directly to your USB device. Technology has never been easier. Simply play your records, plug your USB device in and click record. When finished click record again and your music is stored onto your USB - too easy.

- 2 speed belt drive turntable
- 33.33 and 45 RPM
- Anti-skating control
- Motor off and reverse function
- RCA Phono/line output
- Dimensions : 449(W) x 145(H) x 370(D) x mm

AA-0494

$249.00

3 Channel Microphone Mixer

Combines three microphone audio signals into one for applications like karaoke. Each input has its own volume control.

- No power required
- Inputs: 3 x 6.35mm sockets
- Output: 1 x 6.35mm plug on 3m lead
- Plastic housing
- Weight: 205g

AM-4220

$29.95

All Savings are based on Original RRP
Limited stock on sale items.

PARTY TIME AT JAYCAR

Bubble Machine

Create instant, continuous bubbles with this affordable portable bubble machine! Great special effect for kids parties, weddings or just for fun! Mains adaptor included. Approx 280mm long.

AB-1220

$34.95

Available separately: **Bubble Mania Bubble Liquid (946ml)**

AB-1222 $6.95

Digital Tuner with Metronome

Acoustic tuner and metronome in one. Combines the features of a an acoustic tuner and a metronome. You can tune by plugging in to your pickup or use the built-in microphone. Ideal for music students.

- Requires 2 x AAA batteries
- Size: 110(L) x 35(W) x 20(H)mm

AA-2045

$29.95

Infrared Wireless Stereo Headphones

A great pair of entry-level wireless headphones. Setup is quick and easy and the sound clarity is excellent. The ultra-light design allows them to comfortably sit on your head and you'll hardly know they're there.

$59.95

- Operation distance: up to 15m
- Requires 2 x AA batteries

AA-2049

DMX Spotlights & DMX Controller

Team any of these LED DMX-controlled lights with a controller or software for complete control over your stage, party or DJ lighting setup. Each is 240V powered, individually addressable via DIP switch and includes a mounting bracket.

A Budget 61-LED 4 Ch DMX Spotlight SL-3420 $99.00
Dimensions: 180(L) x 170(Dia)mm

All Aluminium Par 46 5-Channel 94-LED DMX Spotlight SL-3422 $139.00
Dimensions: 300(L) x 135(Dia)mm

Par 64 5-Channel 94-LED DMX Spotlight SL-3424 $169.00
Dimensions: 245(L) x 195(Dia)mm

new

19" Rack Mount DMX Controller

Controls multiple DMX devices, such as lights, fog machines or laser light shows with pre-programmed scenes such as fade, pan, strobe, colour etc. Limited only by the capabilities of the actual DMX devices. Rack mountable and mains powered.

- Controls up to 12 devices
- 16 channels per device
- Dimensions: 482(W) x 133(H) x 70(D)mm

SL-3429 $149.00

FROM $99.00

50W Guitar Amplifier

With a nice clean sound, it also has switchable distortion with variable gain and level controls. Notch gain and 1 kHz shape control give you more flexible sound and it also has an effects loop. Good low-cost rehearsal amp for guitar or keyboards.

- 100 - 350Hz notch gain
- Bass and treble controls
- 10" speaker
- Dimensions: 410(W) x 435(H) x 220(D)mm

CS-2556 WAS $199.00

$129.00
SAVE $70.00

Professional VHF Wireless Microphone System

new

Has enhanced signal reception and is ideal for performers on the go, churches or halls etc. Includes 2 microphones, 1 wireless unit, and plugpack. Microphones require 2 x 9V batteries (not included).

- High-precision quartz crystal locked frequency
- 12 hour battery life
- Up to 80m range
- Carry case included
- Dimension:195(l) x 145(W) x 42(H)mm

AM-4071

$99.00

Dual Channel / Bridged Rack Mount Amplifiers

new

Very versatile rack mount amps that suit a variety of applications. Add a small mixer and use them as a PA amp, or standalone as a foldback amp. They have 1/4" jack inputs, balanced XLR and line-level RCA inputs. Speaker connections are by Speakon connectors or screw binding posts. They can be run as dual channel, stereo or bridged. The build quality of these amps is excellent, with very solid aluminium chassis and front panels so they are a very cost-effective solution for a pro audio application.

- Dual channel or bridged
- Fan cooled
- Separate level controls for each channel
- Clipping and overload protection indicator LEDs

FROM $199.00

Dual Channel / Bridged 200W Rack Mount Amplifier

- Power output: 2 x 100WRMS @ 8ohms, 1 x 380WRMS bridged @ 4 ohms
- Dimensions: 480(W) x 90(H) x 247(D)mm

AA-0477 $199.00

Dual Channel / Bridged 400W Rack Mount Amplifier

- Power output: 2 x 200WRMS @ 8ohms, 1 x 760WRMS bridged @ 4 ohms
- Dimensions: 480(W) x 90(H) x 247(D)mm

AA-0479 $299.00

Dual Channel / Bridged 600W Rack Mount Amplifier

- Power output: 2 x 300WRMS @ 8ohms, 1 x 1140WRMS bridged @ 4 ohms
- Dimensions: 480(W) x 90(H) x 247(D)mm

AA-0481 $299.00

Indoor/Outdoor Speakers

Made from ABS plastic & are weather-resistant, allowing for both indoor or outdoor mounting. Ideal for surround sound, or outdoors on the patio or pool. Brackets are supplied for mounting.

- Speakers: 4" Woofer and 2" tweeter
- 30WRMS
- Sold as a pair
- Cabinet size: 210(H) x 140(W) x 120(D)mm

CS-2430

$79.95 pair

Amplifiers

5W Single Channel Amplifier

A versatile small audio amp for the workshop, test lab or as a small PA or busking amp. RCA and microphone inputs, dual speaker outputs. 12VDC or mains powered.

$29.95

- Dimensions: 190(L) x 170(W) x 85(H)mm

AA-0473

Low Cost Mains Powered Stereo Amplifier

This simple, low cost amp is surprisingly loud! Ideal for a small office, workshop, or as a church PA amp. See our website or catalogue for full specifications.

- Microphone input, bass, treble controls and master volume controls
- Dimensions: 170 x 77 x 157mm

AA-0472

$49.95

2 x 100 WRMS Stereo Amplifier with Remote Control

A no-nonsense stereo amplifier that is rated at a generous 100 watts RMS per channel and will form the heart of an impressive stereo system. Includes remote control to adjust input source, volume, etc.

- 100 watts RMS per channel
- Size 420(W) x 135(H) x 214(D)mm

AA-0470

$199.00

Rave Fog Machine

Produces clouds of white fog on demand. Fantastic for use with laser light shows, mirror balls and other party lighting. Mains powered.

- 70 cubic metres/min fog output
- 800ml fog juice capacity
- Measures: 330(L) x 160(W) x 140(H)mm

AF-1214

$99.95

Spare Fog Juice 1 litre
AF-1212 $17.95

Party Time At Jaycar

www.jaycar.com.au

To order call **1800 022 888**

Jaycar Electronics
Better, More Technical

Prices valid until 23/11/2010. Limited stock on sale items. No rainchecks. All Savings are based on Original RRP

5-in-1 Jump Starter-Inverter-Charger-Compressor-Work Light

Far more than your average jumpstarter this unit has an impressive set of features for a hundred different uses. Tucked in on either side are two tough insulated battery clamps for all your jumpstarting needs, on the front panel you have 2 x 12VDC cigarette lighter sockets for operating 12V appliances, a 5 LED worklight and two dial indicators for air pressure and charge status. Powered by the internal 12V 18Ah SLA battery, it even has a 400W inverter to charge your laptop, etc. See Website for specifications.

- Dimensions: 220(L) x 215(W) x 295(H)mm

MB-3594

Selling fast - stock limited

$149.00

Windscreen Mount Suction Bracket for iPhone®

A handy device to mount a iPhone® to the windscreen for easy access. The strong 80mm diameter suction mount will keep his iPhone® securely attached. The ball and socket joint enables positioning for maximum effectiveness. Will hold an iPhone® with or without a protective back cover.

$19.95

Caution: Always ensure it is mounted so that it does not obstruct your view or cause a distraction.

HS-9004 Note: iPhone™ not included

RESPONSE Precision Car Amplifiers

With improved heat sinks and upgraded low-profile chassis design, each model delivers surprising grunt and performance in a sleek and compact package that fits neatly under a car seat. All include gold plated power and speaker terminals and variable low pass filters. Plus our class AB amps come with variable high pass filters and pass through RCAs; while our class D subwoofer amps feature variable subsonic filter, phase shift and master/slave operation.

2 x 80WRMS Class AB Amplifier
Dimensions: 266(L) x 235(W) x 58(D)mm
AA-0450 $149.00

4 x 50WRMS Class AB Amplifier
Dimensions: 316(L) x 235(W) x 58(D)mm
AA-0451 $199.00

FROM $149.00

2 x 150WRMS Class AB Amplifier
Dimensions: 376(L) x 235(W) x 58(D)mm
AA-0452 $229.00

4 x 100WRMS Class AB Amplifier
Dimensions: 436(L) x 235(W) x 58(D)mm
AA-0453 $299.00

500WRMS Linkable Class D Subwoofer Amplifier
Dimensions: 232(L) x 178(W) x 58(D)mm
AA-0454 $249.00

1000WRMS Linkable Class D Subwoofer Amplifier
Dimensions: 306(L) x 178(W) x 58(D)mm
AA-0455 $369.00

Response Precision 4 x 100WRMS Full Range Digital Amplifier
Dimensions: 306(L) x 178(W) x 58(D)mm
AA-0457 $349.00

12 Month Warranty

Bluetooth Stereo Headset

Easily paired with any Bluetooth device such as a mobile phone or computer. Extremely light and comfortable. Microphone for Bluetooth hands-free capability and lithium-ion rechargeable batteries which will provide hours of use. USB cable included.

AA-2067

$49.95

Ultra High Current Fuses

Patented technology designed for high current protection up to 250 amps found OEM on Ford, GM and Chrysler vehicles. Slo-Blo® feature eliminates nuisance blowing during temporary, short duration overloads. Commonly used for battery and alternator connections and other heavy gauge cables requiring ultra high current protection. Rated up to 32V AC or DC. Terminal studs 8mm.

High Current Fuse Holder	SF-1980 $19.95
Bolt-Down Fuse 125A	SF-1982 $9.95
Bolt-Down Fuse 250A	SF-1984 $9.95
Bolt-Down Fuse 500A	SF-1986 $9.95

FROM $9.95

HID Dual Lamp Conversion Kits - 35 Watt

Used in the latest model luxury and high performance cars, High Intensity Discharge (HID) vehicle headlights are far brighter, whiter and more efficient than their quartz halogen predecessors.

35W HID Xenon Lamps - H4 base
6000K colour temperature comparable to sunlight
Extra bright 3200 lumens

FROM $99.00

SL-3417

Available in two easy-installation models:
HID Dual Lamp H4 Conversion Kit
Low Beam SL-3416 $599.00
HID Dual Lamp H4 Conversion Kit
High/Low Beam SL-3417 $$149.00

SL-3416

Also available:
NEW Replacement Bulb for HID Kit
SL-3417 Cat. SL-3414 $39.95
NEW Spare or Replacement Ballast for HID Kits
SL-3416 and SL-3417 Cat. SL-3418 $49.95

Warning: State roads & traffic authorities prohibit the retrofitting of these products to cars with normal headlights. Advised to be used only for off-road and showroom vehicles when replacing quartz halogen bulbs, or as headlight replacements for HID factory-fitted new model vehicles.

1 Farad Capacitor

Integrate these capacitors into your audio system to avoid the voltage drop that can cause distortion etc. which can damage your valuable speakers.

- Gold plated terminals
- Mounting brackets & hardware included
- Digital voltage display
- Dimension: 260(H) x 75(Dia)mm

RU-6754

$99.00

Sound Proofing for Your Vehicle

Butyl Based Sound Deadening Material

By adding weight to the metal panels of your car, such as door skins, boot lids, quarter panels, etc, you can stop nasty vibrations, reduce road noise, and give your doors and boot a nice solid "thud" when they shut. Each sheet is self-adhesive, and can be easily moulded, cut and stuck onto virtually any metal surface of your vehicle's body, giving you a pleasant, quiet and comfortable ride.

- Thickness: 1.5mm
- Size: 900 x 330mm

AX-3687

$29.95

Self-Adhesive Sound Absorbing Foam

The perfect ultra light weight insulator to use in conjunction with AX-3687. This durable crush and tear- resistant material has one of the highest heat blocking properties available in a single layer synthetic foam-type material. Not affected by oil and does not absorb water. It provides acoustic isolation and excellent thermal insulation for roof, firewall, floor, quarter panels, doors and even as an under bonnet liner.

- Thickness: 5mm
- Size: 660 x 330mm

AX-3662

$14.95

Combination Butyl/Foam Super Sound Deadener

Combining both the sound deadening properties of butyl material, and insulating properties of honeycomb foam, this is an easy single application solution for complete sound deadening and isolation that also offers thermal insulation. Consisting of a layer of our AX-3687 Butyl Based sound deadener and a 3.0mm thick layer of honeycomb foam (similar to our AX-3662), lining the cabin of your vehicle with these sound deadening sheets will give you drastically reduced road noise, less panel vibration and a cooler cabin temperature.

- Thickness: 4.5mm (1.5mm butyl, 3.0mm foam)
- Size: 660 x 330mm

AX-3689

$29.95

In-Dash MP3 Player with Radio

Listen to your favourite MP3s directly from the USB/SD card slot. Featuring PLL tuner with 18FM/12 AM presets, and MP3/WMA playback you will never miss a beat with this in-dash MP3 player.

- Front USB and SD card slot
- MP3 ID3 tag display
- 4 channels x 40W MAX power output
- 4 channels x 20W RMS power output
- 2 channels x 2V line-out

QM-3781

$99.00

CAR & OUTDOOR TIME AT JAYCAR

Replacement LED Automotive Globes

Due in-store mid-Nov 2010

12V BAY15D & BAY15S LED Replacement Lights

Utilising SMD LED technology, these replacement globes offer a 360° arc of illumination and high flux Piranha LEDs for high brightness. Suitable for parkers, reverse, tail and brake light replacements.

9 x White LED BAY15D ZD-0361 $24.95
9 x Red LED BAY15D ZD-0365 $24.95
9 x White LED BA15S ZD-0367 $24.95
9 x Amber LED BA15S ZD-0369 $24.95

$24.95 ea

12V 360° LED Festoon Lights

Replace your interior lights with LED replacements and never have to replace a blown globe again. 360° arc of illumination for even light distribution.

8 x White LED Festoon Globe 31mm
ZD-0481 $16.95
8 x White LED Festoon Globe 36mm
ZD-0483 $16.95

$16.95 ea

12V T10 Wedge Replacement LED Globes

Spruce up the lighting on your set of wheels with some LED replacement globes. The SMD LEDs provide 360° illumination for even distribution of light.

15 x White T10 Wedge Replacement Globe 12V ZD-0495 $24.95
15 x Red T10 Wedge Replacement Globe 12V ZD-0496 $24.95
15 x Yellow T10 Wedge Replacement Globe 12V ZD-0497 $24.95

$24.95 ea

Vifa Car Audio Speaker Range

Used by OEMs for more than 70 years and found in many high end Hi-Fi and home cinema speakers, Danish designed Vifa, have a long track record of excellent design, innovation and exceptional sound quality. The Vifa car audio range includes subwoofers, coaxials and splits. All feature state-of-the-art design and materials - strontium magnets, oxygen-free copper voice coil, composite and carbon fibre diaphrams. For full specifications ask in-store or visit online.

Vifa 10" Subwoofer
200WRMS@2 x 4 ohms
CS-2351 $249.00

Vifa 12" Subwoofer
250WRMS@2 x 4 ohms
CS-2353 $299.00

Vifa 5" 2 Way Coaxial Speakers
60WRMS@4 ohms
CS-2393 $99.00 pair

Vifa 6.5" 2 Way Coaxial Speakers
80WRMS@4 ohms
CS-2395 $129.00 pair

Vifa 6 x 9" 4 Way Coaxial Speakers
150WRMS@4 ohms
CS-2397 $189.00 pair

Vifa 5" Car Speaker Splits 60WRMS
CS-2398 $179.00 Kit

Vifa 6.5" Car Speaker Splits 80WRMS
CS-2399 $199.00 Kit

FROM $99.00

Emergency Caution Light

Compact and visible up to 800 metres away, this super strength plastic caution light contains a strong magnet for placement on vehicles in an emergency situation. With built in IC controlled LED flash, this light has 9 user-selectable flash patterns. Perfect for cars, boats and watercraft safety.

- Requires 2 x AAA batteries
- Dimensions: 105(Dia) x 35(H)mm

ST-3201 $19.95

Cigarette Lighter Battery Monitor

Check the voltage output of your vehicle's main battery quickly and easily. Simply plug this handy voltmeter into the cigarette lighter socket and get an instant LED readout of the electrical system's voltage.

- Display resolution: 0.1V
- Accuracy: +/- 2%
- Operating voltage: 8 - 30VDC

QP-2220 $19.95

X-Glow CREE® LED Torch - 185 Lumens Rechargeable

Built for the serious torch user. It has an extensive range of features suitable for any outdoor activity. It outputs 185 lumens and though it's rechargeable, the induction charging means the torch is fully sealed against water and dust intrusion. Focus control and 2 light modes (on/quick flashing) make this tough and versatile torch an excellent buy. Wrist lanyard included.

- XP-E (Q4) CREE® White LED
- Burn time: 3.5hrs 100% brightness, 30 hrs 10% brightness, 15hrs quick flashing
- IPX4 water resistance rating
- Charging time: 12 hrs
- Dimensions: 45(W) x 142(H)mm

SF-3457 $79.95

3W CREE® LED Adjustable Head Torch

Three modes of operation - high, low and strobe. The beam can be focused quickly from wide to spot by simply sliding the zoom in or out. Comfortable elasticised head strap. Camping, caving, fishing etc.

- Output: 180/80 lumens
- Burn time: 8hrs
- Light modes: High, low, strobe
- Water resistant
- Requires 2 x AA batteries
- Weight: 105g with batteries

ST-3279 Due early November 2010 $39.95

Weather Station/Clock/Photo Frame

Keep tabs on the weather, the time and display photos of the nearest and dearest. A remote sensor sends weather data to the display unit which provides temperature, humidity, trend and forecast information and also displays indoor temperature. Photos can be loaded by a host PC, via SD/MMC card or USB flash drive. Mains plugpack included.

- 12/24 hour clock with alarm
- Time and date display with DST and time zone
- Weather and photo display
- Wall or desk mount
- Mains powered
- Dimensions: 200(W) x 150(H) x 30(D)mm

XC-0345 $159.00

Car Audio Accessories

Twisted Pair RCA Stereo Audio Leads

These double shielded leads reduce unwanted noise providing crisp signals.

- Tinned OFC
- Chemical & moisture resistant
- Split centre pin connection
- Platinum plated ends

5 lengths available:
0.3m WA-1079 $14.95
0.5m WA-1071 $14.95
1.5m WA-1073 $19.95
2.5m WA-1075 $24.95
5.0m WA-1077 $24.95

FROM $14.95

Car Amplifier Wiring Kits

Complete wiring kits for installing an amplifier into you vehicle. Everything you need, power cable, speaker wire, stereo RCA interconnect, 18G remote wire, gold plated fuse holder, 40A fuse, loom tubing, gold plate crimp connectors, grommets, cable ties and screws. Two sizes available:

8G Wiring Kit AA-0442 $59.95
4G Wiring Kit AA-0444 $99.00

FROM $59.95

Visible Deterrent To intruders

CCTV Sticker Large Size

The simple solution to warn intruders. Bright yellow to attract attention. Partner with a dummy camera or two for a complete faux security system or just to warn that the real thing is installed.

- Dimensions: 110(L) x 110(W)mm

LA-5101

$3.95

Solar CCTV Warning Sign

A visible deterrent that will really get attention. With a built-in solar cell, this CCTV Warning sign flashes when there is light available. Double sided tape is included for convenient mounting. Ideal for shops, homes, garages or anywhere you need to advise would-be robbers that you have an expensive CCTV surveillance system.

- Dimensions: 80(L) x 80(W)mm

LA-5103

$14.95

Colour 520TV Lines 23x Zoom Camera

Professional camera capable of 23x zoom. It utilises the Sony SuperHad 1/4" sensor for 520 TVline resolution. See website for full specifications.

- Image sensor: 1/4" Sony SuperHAD Interline Transfer CCD
- Video format: PAL
- Dimensions: 125(L) x 69(W) x 66(H)mm
- Weight: 550g

QC-3508

$499.00

Mini DVR Kit with Button-Hole Camera

Producing high definition video and audio you can capture meetings, conferences or lectures. The kit includes a pinhole camera with different buttonhole options so it's completely covert and discreet. Includes rechargeable battery, charger, AV leads, USB cable, software and dummy buttons for disguising the camera.

- Li-Ion battery
- Recording resolution: Up 720 x 576
- Store up to 32GB on an SD card about 10 hours of video
- 128MB flash memory
- 2" TFT LCD screen
- Camera resolution 420TV lines
- USB interface
- Windows XP Vista, 7 compatible
- Dimensions: DVR: 65(W) x 54(H) x 14(D)mm
  Camera: 22(W) x 34(H) x 15(D)mm

QC-8006

$249.00

Dummy IR Camera

Most criminals aren't completely stupid - if your place looks like it has CCTV surveillance, they'll move on to the place that doesn't. These dummy cameras look totally convincing - they have genuine-looking IR LEDs and a real LED that adds to the illusion. Add a couple of warning signs to complete the installation.

- Requires 2 x AA batteries
- Mounting hardware included
- Dimensions: 175(L) x 85(Dia)mm

LA-5325

$24.95

NEW Professional CCTV Cameras

High Resolution Day / Night Colour CCD Camera

High resolution Sony 1/3" sensor, colour by day, black and white by night resolution is 550TV lines.

- Perfect for use with infra red illuminators.
- High Resolution Sony SuperHAD CCD Sensor.
- Extremely high performance in low light levels
- Flickerless with auto iris control
- Automatic white balance & back light compensation
- High speed electronic shutter
- For full specs ask in-store or visit our Website

QC-8621

$249.00

Also available

NEW High Resolution 550TVL ExView Colour CCD Camera - for very low light conditions

QC-8622 $299.00

NEW Pro 550TVL Dual Voltage CCD Camera QC-8623 $399.00

Network Connect Vandal Proof Mini Dome Camera

Designed to take advantage of power over Ethernet to reduce installation costs and setup time, these dome cameras connect straight to your existing network for complete control. Access the camera through a web interface by hitting the IP address of the device and logging in. The web interface allows you to control the camera around 3-axis, zoom, adjust visual settings, record, take snapshots and setup scheduled recording. 2 models available. Both use H.264/MPEG/JPEG compression. For full specs ask in-store or visit our Website.

FROM $399.00

Network Connect Vandal Proof Mini Dome Camera VGA QC-8624 $399.00

Network Connect Vandal Proof Mini Dome Camera 2MP, Full HD 720P QC-8625 $599.00

RG59 / Power Cable

Combines RG59 coax and 16G power cable. For CCTV and surveillance applications.

- Sold per metre
- Dimensions: 10 x 7.5mm

WB-2017

$1.40 Per metre

2.8" TFT LCD Monitor and AV Recorder

The smallest and lightest LCD monitor on the market with a multitude of applications. Monitor CCTV cameras, record audio and video to an SD card or use it as for playback either through the unit or via the AV out to an external monitor or TV. Rechargeable and ultra-portable, complete with AV lead, instruction manual and charger.

- 2.8" LCD
- 480 x 234 pixel resolution
- Built-in rechargeable battery
- Dimensions: 88(L) x 58(W) x 17(D)mm

QM-3824

$149.00

Outdoor IR Camera

Versatile CMOS outdoor camera with IR illuminator. Supplied with an 18m power/video cable, it could be used stand-alone, or as an additional camera for a DVR.

- 350TV lines
- Day/night operation
- 6.0mm lens
- 180mm adapter cable - DIN to BNC and DC plug
- 12VDC 300mA power adaptor
- Dimensions: 85(L) x 58(Dia)mm

QC-3239

Due late Nov 2010

$59.95

New Professional CCTV

Budget DVR Kit With Colour Cameras

DVR kit that is ideally suited to smaller surveillance installations around the home or office. The system can store over 150 hours of video on the 320GB HDD. Not a PC-based system, but recorded video is indexed in an event log and can be viewed via a computer or external monitor.

Complete with two weather resistant IR cameras, cables, remote control and mains adaptor.

DVR

- 4 x camera inputs
- 1 x composite video output
- MJPEG compression
- SATA hard drive interface
- 320GB Seagate SV35 Surveillance Hard Drive

Camera

- 350TV lines
- In-built infrared illumination
- Day/night operation

QV-3020

Due Mid November 2010

$499.00

Better, More Technical

All Savings are based on Original RRP
Limited stock on sale items.

To order call 1800 022 888

SECURITY TIME AT JAYCAR

Solar Powered Mini Window Alarms

Cost-effective and simple security measure. Use one or more as a stand-alone option or as an addition to an existing electronic security setup. Simply peel the clear backing from the self-adhesive mount and position on a window - no tools required. The solar cell keeps the built-in Ni-MH battery charged and if triggered, the very loud alarm sounds.

Two types are available: one is a glass breakage and vibration sensor, the other is a magnetic reed switch. Suitable for windows, French doors, sliding glass doors and pane glass doors.

- Warning sticker included
- No wiring
- Never needs batteries
- Self-adhesive
- 3 year warranty
- Size: 70(W) x 82(H) x 8(D)mm

$24.95 each

Mini Glass Breakage/Vibration Window Alarm LA-5003 $24.95
Mini Magnetic Entry Alarm LA-5005 $24.95

Shadow G - 3G/GPS Enabled Engine Immobilising Car Alarm

A car alarm is an effective deterrent and a worthwhile investment, but what happens when your wheels get stolen even when you have an alarm? Track it via GPS. In addition to the normal array of sensors and functions you'd expect, this alarm will also track your stolen vehicle via GPS, then send you the co-ordinates via SMS to your mobile phone. The supplied wiring is all black, so is easy to conceal in your existing car's wiring harness. Please note that in order to comply with the power consumption requirements of AS/NZS 3749 the GPS module is sold separately. Designed in Australia to comply with the Australian standard for intruder alarm systems (road vehicles) AS/NZS 3749. See website for full specifications. LA-8966

Also available separately:
GPS Unit LA-8967 $149.00
Spare Remote LA-8968 $24.95

$399.00

LED Remote Controlled Open/Closed Sign

High visibility shop sign with LED open/closed display has high intensity LEDs can be seen from a considerable distance, so customers know if your shop is open for trading or not. It also has a clock display that shows hours, minutes and seconds and you can disable the open/closed display if required. The display is remote controlled and runs from a 9V mains adaptor.

- Dimensions: 362(W) x 242(H) x 25(D)mm

XC-0200

$169.00

Piezo 4-Tone Siren with Controller

A very loud 125dB siren, it has four different tones - police, ambulance, fire engine or truck air horn. Connects to a 12VDC power source and select a tone with the controller. Sturdy moulded plastic construction with metal mounting bracket.

- 125dB
- 12VDC
- Size: 150(L) x 130(Dia)mm

LA-5259

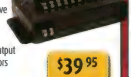
$29.95

CCTV Power Distributor Box

Makes distributing power to multiple CCTV cameras a simple matter. Simply connect a common source up to 30VDC and distribute it to up to 9 slave devices. Screw terminal connection.

- Individually protected PTC output
- Individual status LED indicators
- 1 - 30V AC or DC input
- Dimensions: 138(L) x 65(W) x 28(H)mm

MP-3351



$39.95

Touch Screen LCD Monitors with USB

Touch screen capabilities enables use with a laptop/PC, games console and endless other VGA operating devices. Use it to control a computer or any other USB compatible device. The monitor can be mounted either on the bracket or flush mounted with cradle. Software and adaptor cables included.

FROM $249.00

7" Touch Screen LCD Monitor with USB QM-3744 $249.00
- Dimensions: 178(W) x 122(H) x 30(D)mm

12" Touch Screen LCD Monitor with USB QM-3746 $399.00
- Dimensions: 308(W) x 208(H) x 32(D)mm

Solar Powered Flashing Sign Display

Thousands of uses for this handy little display unit. You simply print out whatever you want to say on the sign, then slip it into the display. The solar cell keeps it flashing ad infinitum. Shop signs, desk photos, warning signs. Wall or table mount in landscape or portrait orientation. Works in normal indoor light levels.

- Dimensions: 132W) x 100(H) x 10(D)mm

LA-5105

$24.95

Licence Plate Camera with IR Illuminator

With advanced signal processing this camera is capable of adjusting to compensate for headlight glare that would normally render a vehicle's numberplates unreadable. Capable of performing in complete darkness for identifying licence plates on vehicles coming and going. Weatherproof and housed in a robust aluminium enclosure.

- Sensor brand: Sony ExView HAD
- Resolution (TV lines): 480
- IR range: 15m
- Power requirements: 12VDC
- Dimensions: 172(L) x 102(W) x 95(H)mm

QC-8614

$399.00

Alarm Relay Module 2 x 15A

When it comes to large alarm installations, there is often a requirement to have several sirens and strobe lights. In order to do this safely, the best way is to use an isolated relay module. This enables you to supply an external power source so as not to overload the power supply on the alarm panel and switch high currents to multiple sirens and strobe lights.

- 15A switching current
- Easy connection via wire terminals
- NO and NC contacts
- Isolated to protect the alarm panel
- Relay coil protection for spike free operation

LA-5558

$19.95

Reversing Cameras

Flush Mount Mini Waterproof Camera for Cars or Trucks

Designed for use in vehicles to give drivers a clear view of car or truck blind spots. Composite RCA cable and the appropriate sized hole saw included.

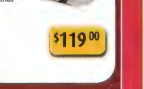
Sensor: CMOS
Resolution: 628 x 512 pixels
Minimum illumination: 0 Lux / F1.2
Camera dimensions: 31(L) x 20(W)mm

QC-3513

$89.95

Colour CCD Wide Angle Waterproof Rear View Camera

The tiny camera is easily mounted with the attached mounting bracket and screws. Ideally it should be fixed to an area above your rear licence plate, or any area at the back of the car that will give a good view. See website for full specs.



Power supply: 12VDC
Dimensions: 27(L) x 20(W)mm

QC-3514

$119.00

Security & Surveillance

www.jaycar.com.au

Limited stock on sale items.

All Savings are based on Original RRP

Jaycar Electronics
Better, More Technical

720p Media Player with USB/SD ports

Media Players are a great way to easily view your collection of downloaded movies or digital pictures on your TV. Once the media player is connected to your TV just attach your USB hard drive or thumb drive with your movies or SD card from your digital camera and start watching. The user interface is as simple as they come with an eye catching design. The remote control gives you complete control over your viewing experience. Extensive file support makes this the perfect home entertainment accessory. Video playback: Supports up to 720p AVI/MP4, DIVX, XVID, Mpeg1/2, RM, RMVB, DAT, MOV (not H.264) and VOB Music playback: MP3, WAV, OGG & WMA audio formats

XC-4206

Also Available:

1080p Media Player with USB/SD/LAN ports

XC-4204 $169.00

$99.95

Universal Camcorder Power Supply/Charger

With 8 different connectors included to suit all the major brands, this universal camcorder power supply is an excellent choice to replace a damaged or lost original unit, or as a spare to take with you on the road. It will automatically set the output voltage depending on which connector is fitted to it and also features a USB output for charging other gadgets such as MP3 players etc.

- LED voltage display
- Output voltage range: 5 - 8.4VDC
- Input voltage: 100-240VAC, 50-60Hz
- Dimensions: 110(L) x 52(W) x 25(H)mm
- Suits camcorder brands: Sony, Canon, Casio, Fuji, Kodak, Olympus, Nikon, Panasonic, JVC, Samsung

MP-3325

$69.95

Light Night LED With Torch

A product that smartly combines a night light and a 6 LED powered torch. Plug the night light into a vertical mains outlet with the torch docked in the induction charging cradle. Whenever you take the torch out it will automatically switch on. The night light base emits a soft but adequate white glow and has 3 modes of operation.

- Torch dimensions: 143(H) x 40(W)mm
- Night light dimensions: 78(L) x 60(W) x 62(H)mm

ST-3141

$24.95

Home Theatre Power Board

Surge protection and filtering is provided to all your home theatre equipment connected to this powerboard as well as current protection via the in-built circuit breaker.

- Provides protection to telephone, data via a network connection, satellite/cable TV and TV aerials.

MS-4024

$64.95

LCD Screen Cleaning Kit

Keep your computer, TV and other LCD screens clean with this easy to use kit. Remove dust and fingerprints without streaking, scratching or staining.

Kit includes:

- Elastic anti-static brush
- Drip-free cleaning solution
- Microfibre cloth

AR-1418

$11.95

AV Senders

5.8GHz Wireless AV Sender

Send audio and video signals around the house from practically any video source - DVD, VHS, set-top box, cable TV etc. Operating on the 5.8GHz band keeps it free from interference on the 2.4GHz band and an external omnidirectional antenna provides a transmission range of up to 100 metres. Extra receiver Cat. AR-1881.

Features:

- 8 channel for minimal interference
- External IR extender
- Compact size

Transmission range: 100m
Frequency: 5.725 ~ 5.875GHz
Sensitivity: -80dBm
Power supply: 7.5VDC, 500mA
Dimensions: 120(L) x 88(W) x 34(H)mm
AR-1880

Also available Extra Receiver AR-1881 $64.95

$89.00

5.8GHz HDMI Sender with Remote Extender

Pipe HD TV to another room in your home. Simply connect the transmitter to the HDMI source & the receiver plugs into your HDMI equipped TV in the remote location. Such a handy device lets you enjoy the benefits of watching Pay TV in the bedroom in full-HD quality.

- IR remote extender
- HDCP 2.0 and CEC compliant
- HDMI 1.3 complaint
- Up to 1080p/60Hz video resolution (full HD)
- On-screen status display
- IR remote control extender built-in
- Dimensions: 180(L) x 140(W) x 39(H)mm

AR-1875

$499.00

Full HD Resolution

UHF Phased Array TV Antenna

This wideband antenna suits analogue or digital TV, and is ideal for fringe areas, where ghosting is a problem, or your aren't in direct line of sight of the transmitter.

- Band 4/5, 470 to 862MHz
- UHF channels - 21 to 69 (27 to 62 in NZ)
- Gain 11-13.5dB
- Measures 610mm x 890mm

LT-3138

$69.95

LCD Alarm Clocks with Temperature and Calendar

With clearly visible size and stylish designs these LCD alarm clocks are ideal for your home or office workspaces. With several handy features they relay the time, date and temperature.

- Displays hour, minute, second, month, date and day
- Thermometer measuring in Celsius or Fahrenheit
- Humidity measurement by percentage

LCD Wall Clock With Temperature & Calendar

- 192mm LCD Screen
- 60mm high digits
- Dimensions: 280(L) x 180.5(H) x 20(W)mm
- Requires 2 x AA Batteries

XC-0221

$39.95

Jumbo LCD Wall Clock With Temperature & Calendar

- 330mm LCD screen
- 100mm High Digits
- Dimensions: 450(L) x 260(H) x 20.5(W)mm
- Requires 3 x C Batteries

XC-0223

$99.00

HDMI Cable Tester

Designed to check and troubleshoot the pin connections of Type A HDMI cables quickly and easily. It's ideal for testing the continuity of each signal pin of an HDMI cable prior to installation. Requires 9V battery.

- Carry case included
- Dimensions: 215(L) x 38(W) x 36(H)mm

AA-0406 WAS $149.00

$89.00

SAVE $60.00

2 Way AV Selector Switch

Switch between two composite video and stereo audio sources. Easy push-button operation.

- Channel separation: 60dB@1kHz
- Cross-talk: 70dB@1kHz
- Dimensions: 135(W) x 50(D) x 32(H)mm

AC-1650

$12.95

Better, More Technical

All Savings are based on Original RRP
Limited stock on sale items.

To order call 1800 022 888

AUDIO/VIDEO TIME AT JAYCAR

Glass Wall-Mount DVD Brackets

Wall mount your DVD player or any other component right under your flat-screen TV. Tempered glass shelves and black anodised aluminium finish to complement modern décor. Also features cable management. Single or double shelf models:

Single Shelf CW-2830 $69.95
Double Shelf CW-2832 $99.95

Universal VESA Adaptor

Adapt any VESA mounting TV to any bracket. Many LCD or plasma brackets on the market are only designed to take TVs with standard 200mm or larger mounting centres, thereby limiting the range of brackets you can use with some TVs. This handy adaptor solves the problem by providing centres for 100, 200 and 300mm VESA mounts. Solid steel construction, black finish.
CW-2815

$24.95

HDMI Leads

Concord HDMI Leads

Feature heavily plated 24K gold plated connectors and extra special oxygen-free heavy copper cabling. Each plug is solidly constructed for frequent, reliable use. Also featured are high quality moulded strain-relief cord grommets.

Male to male 0.5m	WQ-7906 $34.95
Male to male 1.5m	WQ-7900 $39.95
Male to male 3.0m	WQ-7902 $49.95
Male to male 5.0m	WQ-7904 $59.95
Male to male 10.0m	WQ-7905 $89.95

Economy HDMI Leads

A cost-effective solution without compromising quality or performance. All have gold plated connectors and are fully HDMI v1.3b and HDCP compliant.

1.5m HDMI Lead	WV-7915 $24.95
3.0m HDMI Lead	WV-7916 $34.95
5.0m HDMI Lead	WV-7917 $49.95

Bargain HDMI Lead 1.5m

Made from 99.99% pure copper with triple layer shielding and nickel plated connectors, these HDMI are a bargain.

- Supports 1080p
- HDMI 1.4 compliant
- 1.5m long

WV-7914

$9.95

Buy 4 for $25
Save $14.80

Outdoor Omni-Directional UHF/VHF Amplified Digital Antenna

With inbuilt low noise and high gain booster, this compact and weather resistant outdoor digital antenna is ideally suited for caravans, boats, and other fixed or mobile applications where space is constrained or harsh environmental conditions require a little extra durability. Excellent wide frequency reception for local free-to-air analogue and digital TV, DAB+ digital radio as well as FM radio transmissions. It can be either base mounted or mast mounted; and includes mounting bracket, 12V mains power adaptor, 12V in-car charger and PAL to F coaxial cable.

- SMD technology
- Anti-rust and UV protected
- Receiver dish size: 350(Dia) x 60(H)
- Mounting base size: 120(Dia) x 70(H)

LT-3141 WAS $89.95

Ideal for Caravans, RV's etc

$79.95
SAVE $10.00

Indoor Flat Panel UHF/VHF Amplified Digital Antenna

Enjoy full Digital TV picture resolution from this sleek and attractive package. This flat panel indoor amplified digital antenna features low noise circuitry, multidirectional reception and auto gain control - receiving both local free-to-air analogue and digital TV as well as DAB+ digital radio signals with remarkable consistency and crystal-clear clarity. Includes 6V 100mA mains adaptor and PAL to F coaxial cable. Mount it either freestanding, on your wall or even on your ceiling in either vertical or horizontal position.

- Panel size: 227(W) x 235(H) x 14(D)mm

LT-3131

$49.95

Indoor TV Amplifier/Splitters

Boost your TV signal indoors. The antenna lead is plugged into the amplifier, and there are two outputs for two TVs, both have a 12dB boost. One outlet can be used for FM stereo if required.

- Runs on 240VAC mains
- Includes a LED power indicator
- Australian made
- 2 Way

LT-3288

$66.50

Also available:
4 Way Indoor TV Amplifier/Splitter
LT-3287 $99.00

Brush Cable Entry Wall Plate

Single gang brush plate for cable entry through walls etc. Suitable for pre terminated cables going to LCD or plasma screens, and particularly suited to HDMI cables as they can't be split, spliced or field-terminated.

PS-0291

$9.95

VGA Plug to Sockets

VGA plug to socket right angle adaptor.

- Available with the socket angles up or down

Socket Angled Up
PA-0898 $8.95
Socket Angled Down
PA-0899 $8.95

Digimatch UHF/VHF Diplexer with DC Bypass

If you want to install a VHF and a UHF antenna on the same cable, you'll need a diplexer. Easy installation and the cable entry is sealed against the weather. Matchmaster quality, suitable for Australia and New Zealand, supplied with heavy duty clamp.

- HDTV compliant
- F connections for faster installations
- Fully screened and weatherproof
- Dimensions: 112(W) x 108(H) x 35(D)mm

IT-3082

$29.95

IR Extenders

IR Remote Control Extender

Extend the range of your IR remote control up to 100m. Great if you want to keep your home theatre components out of sight or make absolutely sure the kids turn the TV off when they're supposed to. Mains plugpacks for transmitter and receiver included.

- Transmission range: Up to 100m line of sight
- Frequency: 433MHz
- Dimensions: 100(Dia) x 120(H)mm (including antenna)

AR-1817

$49.95

16 Channel IR Remote Control Extender

Extend the range of your IR remote up to 30m. One of 16 coded channels can be set using by DIP switch so you'll be free from interference. Plugpacks for transmitter and receiver included.

- Frequency: 433.92MHz
- Modulation: Amplitude key shifting
- Sensitivity: -90dBm
- Dimensions: 78(Dia) x 40(H)mm

AR-1818

$79.95

www.jaycar.com.au

Limited stock on sale items.
All Savings are based on Original RRP

Jaycar Electronics
Better, More Technical

Sight N' Sound

Mini Desktop Wind Generator with LED

Quite possibly the world's smallest wind generator! Use a fan or outside the wind to blow on the rotor blades and create electricity to power two blue and one green LED. Made from durable ABS plastic. A novel educational gift for young and old.

- Blade diameter: 60mm
- ABS plastic stand height 170mm
- Ideal wind speed around 9.6km per hour if used outdoors
- Small components.
- Suitable for ages 3+

GT-3752

$19.95

5-Blade Wind Generators

Compared to our earlier model 500W wind generator with 3 blades, this updated 5-blade version offers many improvements in features and performance. Blade rotational diameter and rotating speed are significantly reduced, improving long term reliability, safety and noise levels. Electrical efficiency is far greater, especially at lower wind speeds around 5m/s or less. The charge controller now features a dump-load function to slow down blade rotation when the battery is fully charged. See our website for full details and data.

NOTE: This wind generator is design for permanent terrestrial installations only! Mounting tower and hardware not included.

5-Blade Wind Generator
24VDC 500W MG-4542

$949.00

Spares:

Set 5 Spare Blades (MG-4542)	MG-4544 $129.00
5-Blade Hub (MG-4542)	MG-4546 $79.95
Dump Load Charge Controller	MG-4548 $299.00

Portable Fold-Up Solar Panel Kits

Excellent for your next camping, 4WD or boating trek, this fold away solar panel and charging kit allows you to easily charge your batteries (not included) allowing you to run power, lights, TV etc wherever you stop. Each model features alligator clamp connections on a 4m lead, has the charge controller included so you can connect directly to your battery without fear of over-charging, and is supplied with a heavy duty metal carry handle and latches, plastic protective corners and a durable nylon carry bag. Three sizes to choose from, all are 12V.

FROM $399.00

40W Folding Solar Panel*	ZM-9132 $399.00
80W Folding Solar Panel	ZM-9130 $649.00
120W Folding Solar Panel*	ZM-9134 $899.00

* 40W & 120W models due end Nov 2010

Powertech Monocrystalline Solar Panels

As strong and tough as the better known brands, but at a more attractive price.

- Sizes range from 5 watts to a massive 175 watts
- For full technical spec ask in-store or visit online
- QC tested - all come with test certificate
- 20 year limited warranty

	CAT	NOW
12V 5 Watt	ZM-9091	$89.95
12V 10 Watt	ZM-9093	$89.95
12V 20 Watt	ZM-9094	$129.00
12V 40 Watt	ZM-9095	$249.00
12V 65 Watt	ZM-9096	$399.00
12V 80 Watt	ZM-9097	$449.00
12V 120 Watt	ZM-9098	$695.00
24V 175 Watt	ZM-9099	$949.00

Pure Sine Wave Inverters - 180W to 2000W

Provide ample power in mobile and permanent installations. Ranging from 180W to 2000Wand have been selected and rigorously tested for durability and reliability. Each has 240VAC outlet and a USB port for powering your gadgets. Suitable for applications where you want to run sensitive equipment.

FROM $199.00

180W 12VDC to 230VAC	MI-5160 $199.00
380W 12VDC to 230VAC	MI-5162 $269.00
600W 12VDC to 230VAC	MI-5164 $399.00
1000W 12VDC to 230VAC	MI-5170 $799.00
1500W 12VDC to 230VAC	MI-5172 $1099.00
2000W 24VDC to 230VAC	MI-5174 $1349.00

Books - Solar that Really Works

A highly informative and practical guide showing the do's and don'ts of DIY solar installation. From caravans to fishing lodges, it features detailed descriptions of working solar systems with illustrations. Written by acclaimed Australian author Collyn Rivers.

Softcover, 82 pages, 290 x 210mm
BE-1535

$42.50

Also available in this series:

Motorhome Electrics	BE-1536 $42.50
Solar Success	BE-1537 $47.50

Telescopic Vertical Axis Wind Generator

Can be mounted on a mobile home, caravan, or small building. The telescopic design allows you to fold the generator to half its height when not in use and an LED display gives a readout of output voltage to know when it is working effectively. Cable mounting bars, and a strong magnetic base are included.

- Voltage output: 12-14VDC
- Current output: 4A max
- Compact design with no spinning blades
- Not sensitive to wind direction
- Effective in wind speeds of 8 - 10m/s
- Weight: 4.5kg
- Dimensions: 455/655(H) x 280(W) x 150(D)mm

MG-4570

$399.00

Solar Lighting Kit - 10W

Kit features high efficiency copper indium selenide(CIS) solar panel with integrated charge controller, 1x5W CFL lamp, E27 base, 2x1W LED lamps, 8Ah SLA battery, connecting cables, fuse and switch. All you need to to build a basic solar powered light system.

MP-4552 WAS $219.00

$179.00
SAVE $40.00

Wind Generators

As well as the 200W model we now have a super-compact 300W version, and a big 500W unit for those who want to generate some serious power. All models feature external charge controllers with three-phase AC output, so you can install a long cable run without worrying about DC voltage drop.

NOTE: All wind generator models are supplied without mounting tower and associated mounting hardware.
WARNING: These wind generators are suitable for permanent terrestrial installations ONLY!

FROM $399.00

200W 12VDC
- Number of Blades: 3
- Included: generator, blades, tail, hub, nose cone, external charge controller

MG-4520 $399.00

Check out our new 300W Lightweight Wind Generators!

300W 12VDC MG-4580 $599.00
300W 24VDC MG-4582 $599.00

Features: moulded, compact, efficient blade design, are lightweight, have neodymium magnets, and the charge controllers are built into the generator heads.
- Number of Blades: 3
- Included: generator, blades, tail, hub, nose cone

Spare parts available. See our catalogue or website for more details

500W 24V
- Number of Blades: 3
- Included: generator, blades, tail, hub, nose cone, charge controller

MG-4540 WAS $999.00

$899.00
SAVE $100.00

Better, More Technical

All Savings are based on Original RRP
Limited stock on sale items.

To order call 1800 022 888

I.T. TIME AT JAYCAR

2MP Web Camera with Microphone

Ideal for podcasting or creating a YouTube masterpiece. No drivers required, just plug and shoot. Built-in microphone included for adding sound.

QC-3233

$39.95

Dual HDD 2.5"/3.5" SATA Dock with Offline Clone Function

This dual SATA dock will accept 2 x 2.5" or 2 x 3.5" (or one of each) SATA HDDs/SSDs. Just dock a drive with a complete install of an operating system, dock an empty drive and press the big red clone button. Can also be used as a regular SATA dock with mountable drives on your operating system. Also has the unique ability to copy hard drives with the computer off!

USB 2.0 or eSATA for connection to PC.

$79.95

- Dimensions: 125(L) x 112(W) x 60(H)mm

XC-4695

Note: HDD not included

Dual 2.5/3.5" SATA HDD Docking Station - USB 3.0

USB 3.0 ready dual SATA docking station for the home or office. Dock two 3.5 or 2.5 inch SATA drives or one of each, and in a flash you can back up gigabytes, terabytes or petabytes of information without the hassle of installing hard drives in enclosures or in the PC.

$99.00

- Dimensions: 130(W) x 61(H) x 103(D)mm

XC-4697

Note: HDD not included

Rack Mount 16 Port 10 / 100Mbps Fast Ethernet Switch

10/100Mbps 16 Port Rack Mount HUB with simply and easy-to-read interface, has 16 LEDs for each port's status. It can satisfy the different demands from house, multimedia classrooms, Internet cales to enterprise networks.

$89.95

- 16 Port
- 10/100Mbps
- IEC power connection
- Dimensions: 440(L) x 123(W) x 44(H)mm

YN-8085

600VA 375W Line Interactive UPS

Compact and completely self-contained, this is the ideal backup solution for your data or other important equipment. It has 3 surge-protected outlets as well as 3 outlets backed up by the UPS. It also has RJ11 ports for protecting phone or fax lines.

$119.00

- Cold start feature
- Software included
- Rating: 375W, 600VA
- SLA battery: 7Ah
- Supply voltage 220 to 280VAC
- Backup time: 3 min at full load
- Recharge time: 10 hrs
- Output waveform: Step sine wave
- Dimensions: 268(L) x 180(W) x 80(H)mm

MP-5222

USB 3.0 Port Upgrade Kit

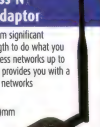
Add two USB 3.0 ports to the front of your desktop PC for compatibility with the next generation of superfast USB 3.0 hard drives, flash drives and other assorted peripherals. The front panel will fit neatly into the 3.5" FDD slot of most PC cases. Each port has a USB 3.0 cable running from the rear which should be plugged into the ports on the supplied PCI-E card.

$79.95

XC-4147

High Power Wireless-N USB 2.0 Network Adaptor

Able to reach wireless networks from significant distances with enough signal strength to do what you need. The unit can connect to wireless networks up to 1.5km away. The supplied software provides you with a myriad of specifications of wireless networks broadcasting in your area.



$69.95

- Dimensions:75(L) x 58(W) x 10(H)mm
- Antenna: 172(H)mm

YN-8306

Wireless-N Broadband Router with 4 ports

Expand your network with ease, reliability and security. A Wireless-N router with a wireless access point function combined with the flexibility of a 4-port switch, and a built-in firewall. Setup is streamlined through the configuration wizard where you can change dozens of settings.

$69.95

- 802.11n
- Provides up to 3 times the transmission rate and double the range of 802.11g products
- Supports UPnP and DDNS
- Meets 64/128-bit WEP, WPA, and WPA2 security standards
- Detachable antenna

YN-8305

Laptop Essentials

USB 5-Button Laser Mouse

All the normal mouse functions - left and right click, scrolling, plus forward, back and quick-launch button. Ergonomically shaped for fatigue-free use.

$17.95

- Plug and play - no drivers required
- Windows 2000, XP, Vista, 7

XM-5240

USB Optical Mini-Mouse

If you own a laptop or netbook, there's no doubt a mouse is easier to use than a touchpad. Take this to school, the office or on business trips. It's small enough not to take up much space, but big enough to be functional. Ideal for the kids first starting to use computers too.

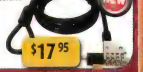
$9.95

- Scrolling wheel
- Plug and play
- Compatible with Windows 2000, XP, Vista, 7

XM-5242

Notebook Combination Cable Lock

As easy as typing in four digits to unlock your phone, this laptop security cable has a four digit combination that you can customise for security. It's 1.8m long and has a swivel on the end so moving it around your desk area will not be a problem.



$17.95

- 1.8m long
- 4 digit combination
- Steel lock mechanism

XC-4639

Wireless 2.4GHz Multimedia Remote and Keyboard

Wireless USB Trackball Remote Control

The trackball works as a mouse or any other pointer device can be used to type numbers or text like a mobile phone. Also features quick-launch keys, and controls for multimedia use. No software or drivers needed - just plug in the receiver. Requires 2 x AA batteries.

$79.00

SAVE $10

- 2.4GHz frequency
- 10m range
- 19mm optical trackball & mouse keys
- USB dongle receiver
- Microsoft Windows XP, MCE/Vista compatible
- Dimensions: 180(L) x 50(W) x 30(H)mm

XC-4940 WAS $89.00

Wireless Trackball Keyboard

Designed for use with PC-based home theatre systems, multimedia and gaming PCs, this keyboard sits on your lap so you can control everything from your couch! The space saving trackball control eliminates the need for a mouse and the conveniently placed left/right buttons are great for gaming. Simply plug-in the USB receiver to your PC. Requires 2 x AA batteries.

$99.00

- 2.4GHz frequency
- 10m range
- 12 Internet/multimedia hot keys
- Windows XP & Vista compatible

XC-4941

Renewable Energy & Power

Remote Control Racing Hovercraft

Massive power slides, high speeds drifts and even jumps are all part of the repertoire. Two brushless ducted fan motors are responsible for the power, one blowing downwards to generate lift, and the second (and more powerful) motor providing the forward thrust. Powered by a high capacity 1800mAh 11.1V Li-PO battery, and controlled by a 2.4GHz radio system, be prepared to waste many, many hours. See website for full specs.

- Dimensions: 193(L) x 280(W) x 113(W)mm

GT-3740

$249.00

Also available **Electronic Gyroscope (to suit GT-3740)** GT-3741 $29.95

Sea Scooter

Designed specifically for family fun in the pool, lake or protected beaches. It's easy to manoeuvre and control with finger-tip controls on the handlebars and can even be used for shallow snorkelling. Lightweight, powerful and portable.

- Powered by 24V 12Ah battery (battery included)
- Up to 1 hour's use time or 40min continuous
- Thrust: 5kgf
- Speed: 3.8kmh

$249.00

Note that this item should be used under the supervision of a responsible adult.

GG-2350

Domestic Ultrasonic Cleaner

Cleans all your watches, jewellery, fountain pens, dentures, razor heads, printer heads, small silverware and small machined parts. Mains powered and easy to use. Fill the tank with water, add a mild cleaning solution and set the timer. The LCD tells you how long to go and the timer is adjustable from 1:30 to 30 minutes.

- Timer setting: 1:30 - 30 minutes
- Tank volume: 550ml
- Power consumption: 50W

YH-5408

$79.95

Micro Solar Car Racer

The smallest solar powered car we've seen. Don't let it's miniscule size fool you, yes it actually does work! Shine a lamp on its solar panel and watch it travel across your desk. Shine a higher powered torch on it and you'll see it take off at a surprisingly furious pace. Adjust the front wheel steering so it goes around in circles. Comes in its own see-through screw top case.

- Dimensions: 31(L) x 20(W) x 15(H)mm

GT-3750

$14.95

3-in-1 USB Microscope

Explore the miniature world with your microscope. You can use it as a conventional optical microscope, a digital microscope or snap the USB camera into the top and capture images to your PC or Mac. It comes with slides and tools for manipulating your scientific prizes.

- Software included
- Magnification: 50 - 100x, 100 - 200x, 200 - 400x
- Requires 2 x AA batteries
- Works with Windows 2000, XP, Vista or Mac OS 10.4
- Size: 112(W) x 132(D) x 260(H)mm

QC-3241

$89.00

4-Channel 4 Engine UFO

One of the weirdest flying contraptions we've ever seen. A four-engine, four-rotor flying widget. Each channel and motor on the craft is colour-coded so you can easily identify what makes it go where. Once you get the hang of it, you'll have hours of fun! It also has a built-in rechargeable Li-ion battery that recharges from the remote unit. 20 minute charge gives about 5 minutes of flight time.

- Requires 6 x AA batteries
- Size: 230(Dia)mm

GT-3782

$69.95

Kid's Digital Photo & Video Camera

The kids will enjoy hours of creativity with this digital photo & video camera. The robust design can withstand heavy duty play. It has a 16MB internal memory and can capture up to 120 still photos or up to 50 seconds of video.

- Requires 4 x AA batteries
- Camera driver software and USB cable included
- Windows 2000, XP & Vista compatible
- Suitable for ages 3+

QC-3188 WAS $49.95

$39.95 SAVE $10.00

Aquapod Bottle Rocket Launcher

All you need is a common bike pump and any 2 litre plastic soft-drink bottle with a bit of water in it. Not only does the Aquapod launch a bottle up to 100 feet in the air, but it has a built-in safety valve that releases pressure at 60psi in order to keep everyone safe from over-pressurizing the launcher. Built to last!

GT-3014

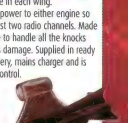
$34.95

38 Channel UHF Transceiver Set

Everything you need for mobile CB communications.

- Rechargeable batteries and dual charging cradle - Includes 2 x 0.5W output handsets
- Up to 5km transmission range
- CTCSS function
- Ideal for bush walking, camping, sports etc.
- Sold as a pair
- No license required

QC-1026



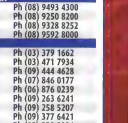
$114.00

RC Twin Engine Model Jet

Driven by two brushless motors, one in each wing. Steering is achieved by varying the power to either engine so this makes it easy to control with just two radio channels. Made from ultra-light Styrofoam so is able to handle all the knocks and crashes without causing serious damage. Supplied in ready to run kit form with lithium-ion battery, mains charger and is controlled by a responsive remote control.

- Recharges in 20 - 30 minutes for about 5 - 6 minutes of flight time
- Recommended for ages 8+
- Wingspan: 290mm

GT-3780



$49.95

YOUR LOCAL JAYCAR STORE

Australia Freecall Orders: Ph 1800 022 888

AUSTRALIAN CAPITAL TERRITORY	
Belconnen	Ph (02) 6253 5700
Fyshwick	Ph (02) 6239 1801
NEW SOUTH WALES	
Albury	Ph (02) 6021 6788
Alexandria	Ph (02) 9699 4699
Bankstown	Ph (02) 9709 2822
Blacktown	Ph (02) 9678 9669
Bondi Junction	Ph (02) 9369 3899
Brookvale	Ph (02) 9905 4130
Campbelltown	Ph (02) 4620 7155
Coffs Harbour	Ph (02) 6651 5238
Croydon	Ph (02) 9799 0402
Erina	Ph (02) 4365 3433
Gore Hill	Ph (02) 9439 4799
Hornsby	Ph (02) 9476 6221
Liverpool	Ph (02) 9821 3100
Maitland	Ph (02) 4934 4911
Newcastle	Ph (02) 4965 3799
Penrith	Ph (02) 4721 8337
Rydalmere	Ph (02) 8832 3120
Sydney City	Ph (02) 9267 1614
Taren Point	Ph (02) 9531 7033
Tweed Heads	Ph (07) 5524 6566
Wollongong	Ph (02) 4226 7089
NORTHERN TERRITORY	
Darwin	Ph (08) 8948 4043
QUEENSLAND	
Aspley	Ph (07) 3863 0099
Caboolture	Ph (07) 5432 3152
Cairns	Ph (07) 4041 6747
Capalaba	Ph (07) 3245 2014
Ipswich	Ph (07) 3282 5800
Labrador	Ph (07) 5537 4295
Mackay	Ph (07) 4953 0611
Maroochydore	Ph (07) 5479 3511
Mermaid Beach	Ph (07) 5526 6722
Nth Rockhampton	Ph (07) 4926 4155
Townsville	Ph (07) 4772 5022
Underwood	Ph (07) 3841 4888
Woolloongabba	Ph (07) 3393 0777
SOUTH AUSTRALIA	
Adelaide	Ph (08) 8231 7355
Clovelly Park	Ph (08) 8276 6901
Gepps Cross	Ph (08) 8262 3200
Reynella	Ph (08) 8387 3647
TASMANIA	
Hobart	Ph (03) 6272 9955
Launceston	Ph (03) 6334 2777
VICTORIA	
Cheltenham	Ph (03) 9585 5011
Coburg	Ph (03) 9384 1811
Frankston	Ph (03) 9781 4100
Geelong	Ph (03) 5221 5800
Hallam	Ph (03) 9796 4577
Melbourne	Ph (03) 9663 2030
Ringwood	Ph (03) 9870 9053
Shepparton	Ph (03) 5822 4037
Springvale	Ph (03) 9547 1022
Sunshine	Ph (03) 9310 8066
Thomastown	Ph (03) 9465 3333
Werribee	Ph (03) 9741 8951
WESTERN AUSTRALIA	
Maddington	Ph (08) 9493 4300
Midland	Ph (08) 9250 8200
Northbridge	Ph (08) 9328 8252
Rockingham	Ph (08) 9592 8000
NEW ZEALAND	
Christchurch	Ph (03) 379 1662
Dunedin	Ph (03) 471 7934
Glenfield	Ph (09) 444 4628
Hamilton	Ph (07) 846 0177
Hastings	Ph (06) 876 0239
Manukau	Ph (09) 263 6241
Mt Wellington	Ph (09) 258 5207
Newmarket	Ph (09) 377 6421
New Lynn	Ph (09) 828 8096
Palmerston Nth	Ph (06) 353 8246
Wellington	Ph (04) 801 9005

NZ Freecall Orders Ph 0800 452 922

Arrival dates of new products in this flyer were confirmed at the time of print. Occasionally these dates change unexpectedly. Please ring your local store to check stock details. Prices valid to 23rd November 2010. All savings are based on original RRP

Head Office
320 Victoria Road, Rydalmere NSW 2116
Ph: (02) 8832 3100 Fax: (02) 8832 3169

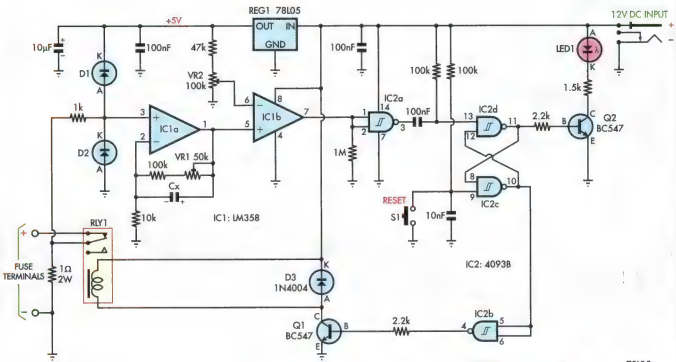
Online Orders
Website: www.jaycar.com.au
Email: techstore@jaycar.com.au

Jaycar

Better, More Technical

CIRCUIT NOTEBOOK

Interesting circuit ideas which we have checked but not built and tested. Contributions from readers are welcome and will be paid for at standard rates.



Electronic fuse employs a relay

While many power supplies can be set to limit their output current to a defined level, to protect the circuit they are powering, no such protection is available if you are powering a circuit from a battery. If a fault develops, the circuit can blow before you have a chance to disconnect it.

Of course, you can fit a fuse in series with the supply line to the circuit under test but it will blow if a fault develops. Or perhaps it won't blow sufficiently quickly to protect the circuit. And repeatedly having to replace fuses becomes a nuisance as well.

The alternative is to use an electronic fuse. This circuit uses a relay to make and break the circuit.

The current drain of the circuit under test is monitored by a 1Ω 2W resistor which is placed in series with the supply line. The voltage across this 1Ω resistor is monitored by op amp IC1a which has an adjustable gain of between 11 and 16, as set by trimpot VR1.

The resultant DC voltage from pin 1 of IC1a is fed to pin 5 of IC1b which is configured as a comparator. Trimpot VR2 provides an adjustable voltage reference to pin 6 of IC1b and this is compared with the amplified signal from IC1a.

If IC1b's threshold is exceeded, its pin 7 goes high and this is fed to Schmitt trigger inverter IC2a which then "sets" the RS flipflop comprising gates IC2c & IC2d. Pin 11 of IC2d then goes high to turn on transistor Q2 and LED1 while pin 4 of IC2b also goes high to turn on Q1 and the relay which then disconnects the load.

The circuit stays in this state until the RS flipflop is reset by pushing switch S1.

Capacitor Cx, across the feedback resistance of IC1a, is used to simulate a slow-blow or fast-blow fuse and can be selected by trial and error.

Changing the gain of IC1a or the value of the sensing resistor changes the fuse rating of the circuit.

Michael Azzopardi,
Deer Park, Vic. ($50)

Issues Getting Dog-Eared?

Keep your copies safe with these handy binders

Available Aust. only. Price: $A14.95 plus $10.00 p&p per order (includes GST). Just fill in and mail the handy order form in this issue; or fax (02) 9939 2648; or call (02) 9939 3295 and quote your credit card number.

Golf buggy battery charger control

This novel circuit controls a 36V lead-acid battery charger, preventing over-charge and keeping the battery topped up without the need for float charging. The circuit operates from the battery so no additional power supply is required. It incorporates hysteresis to prevent the charger from being switched on and off rapidly.

The hysteresis is implemented with a Mosfet-based adaptation of the original 2-transistor Schmitt trigger circuit.

The charger's mains supply is switched by a mains-rated (250VAC) relay with a 24VDC coil (RLY1). In order to run it off a 36V battery, several series resistors (22Ω, 180Ω and 100Ω) limit the coil current. Switch S1 is wired in parallel with the relay, allowing the circuit to be "bootstrapped" if the battery voltage is too low to operate RLY1.

The battery voltage is monitored via diode D1, zener diodes ZD1 and ZD2 and trimpot VR1. The three diodes reduce the voltage by around 22V, while VR1 divides it down further so that Mosfet Q1's gate voltage is just high enough for it to turn on when the battery is fully charged.

Since charging golf cart batteries involves high current (up to 40A), the charger output has a lot of ripple. Diode D4, the parallel 1MΩ resistor and the two 1μF MKT capacitors filter it out of the feedback voltage. D4 conducts during the low point of each cycle, otherwise the 1MΩ resistor allows the capacitors to slowly charge.

As a result, the voltage at Q1's gate is determined by the actual battery voltage.

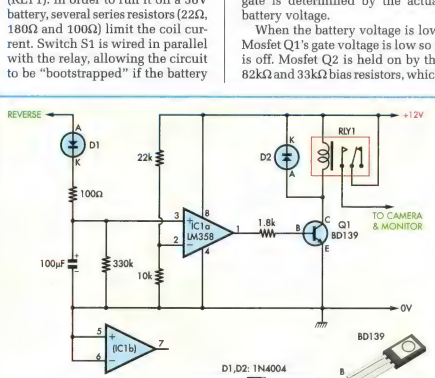
When the battery voltage is low, Mosfet Q1's gate voltage is low so it is off. Mosfet Q2 is held on by the 82kΩ and 33kΩ bias resistors, which keep its gate voltage below the maximum rating (typically 20V).

Merv Thomas is this month's winner of a Peak Atlas Test Instrument

When the battery voltage rises enough to switch on Q1, it pulls Q2's gate towards ground, switching it (and therefore RLY1) off. The voltage across the 100Ω resistor also drops, reducing Q1's source voltage and therefore increasing the amount by which its gate voltage must drop in order to resume charging.

To ensure that the hysteresis is not affected by ripple from the charger, power for the relay (and thus the 100Ω resistor) is filtered by a 22Ω resistor and 470μF capacitor. Because the 100Ω resistor forms a voltage divider with the relay coil and series 180Ω resistor, the amount of hysteresis is determined by the battery voltage and the position of VR1.

To set the voltage at which charging ceases, turn trimpot VR1 fully anti-clockwise and allow the connected battery to charge until



Reversing camera delay

This circuit is intended to maintain the power supplied to a reversing camera and monitor. The problem with simply attaching the video system to the reversing light controlled by the gear selector is that when you are backing a trailer or caravan, you inevitably need to select forward and reverse as you manoeuvre. The video display then takes some time to stabilise each time reverse gear is re-selected.

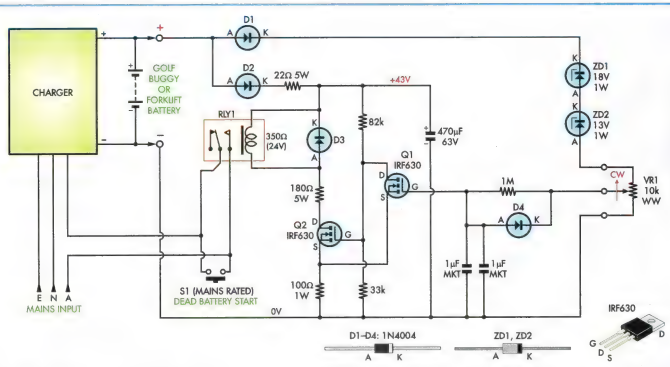
Op amp IC1a (half of an LM358) is connected as a comparator. A voltage divider consisting of the 22kΩ and 10kΩ resistors applies about +4V to pin 2 of IC1a. With the 100μF capacitor at pin 3 discharged, the output at pin 1 is close to 0V. Hence, transistor Q1 is turned off and so is the relay.

When reverse gear is selected, the reversing light is turned on, so the 100μF capacitor charges via diode D1. The 100Ω resistor limits the surge current through D1. When the 100μF capacitor charges above +4V, the output of IC1a goes high, turning on Q1 and the relay. The relay in turn switches the supply to the camera and monitor.

When reverse is de-selected for a manoeuvre, diode D1 prevents the capacitor from discharging through the reversing light filament but it slowly discharges through the 330kΩ resistor. This maintains the video display for a suitable time delay.

If reverse is re-selected before the capacitor discharges below +4V, it is re-charged. If not, IC1a switches off Q1 and the relay. Diode D2 prevents any spike voltage (back EMF) from the relay from damaging the transistor.

The time that the video display is held on depends mainly on the size of the capacitor and the 330kΩ



it begins gassing. At that point, slowly turn VR1 clockwise until the charger switches off.

Note that golf buggy batteries can produce a significant volume of hydrogen during charging so great care must be taken when connecting or disconnecting the battery. Alligator clips are not recommended as these can easily cause sparks which can ignite the hydrogen. For the same reason, they should not be charged in a confined space.

Merv Thomas,
Townsville, Qld.

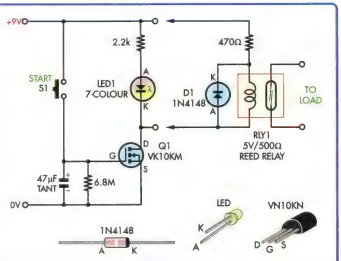
Lullaby & lamp timer

This circuit provides a soft light to lull a young child to sleep. The light fades away after about 10 minutes. It could also be used to switch off an MP3 player or similar program source. In essence, it is just a FET which controls a 7-colour LED (Altronics Cat. Z0985, Z0986 or Z0987).

On pressing the start switch S1, the 47µF tantalum capacitor is charged to 9V. This turns on FET Q1 and the associated 7-colour LED (LED1). As the capacitor slowly discharges via the 6.8MΩ resistor, the FET slowly dims the LED.

If you want to add the music source, the relay and diode D1 will also be required.

A. J. Lowe Bardon, Qld. ($35)



resistor; the larger these values, the longer the hold time.

The prototype circuit used a relay with a 90Ω coil and so a BD139 was selected for transistor Q1. Miniature relays typically have much higher coil resistances so a smaller transistor such as a BC337 would suffice if one of these is used.

Peter Wright,
Warnbro, WA. ($45)

Looking for real performance?

- Learn about engine management systems
- Projects to control nitrous, fuel injection and turbo boost systems
- Switch devices on and off according to signal frequency, temperature & voltage
- Build test instruments to check fuel injector duty cycle, fuel mixtures and brake & temperature

Price: Aust. $A19.80 plus $A10 P&P ($A12 P&P NZ; $A18 P&P elsewhere) – see the order form in this issue or www.siliconchip.com.au for ordering details.

High-performance shortwave converter

In conjunction with a good quality manually-tuned AM car radio, this shortwave converter will provide coverage from 6MHz through to 17MHz, on AM and SSB.

The circuit uses just one low-cost crystal to provide suitable oscillator injection at the fundamental and harmonics, with the car radio effectively being used as a tunable IF strip. This gives a stable, low-drift, double-conversion receiver.

For SSB (single sideband) reception, a varicap-tuned preselector involving VC1 & VC2 allows the mixer (Q2) to discriminate against image reception and selects the band of interest. The tuning of this section will select either above or below the local oscillator to give eight 1MHz-wide bands with no switching.

The crystal is a cheap and easily obtained 3.58MHz unit, providing the fundamental at 3.357945MHz and harmonics at 7.16MHz, 10.738MHz and 14.318MHz. To receive the full 31-metre broadcast band, for example, the preselector is simply tuned to peak at 9MHz and the car radio will then tune from 10.738MHz minus 550kHz to 10.738MHz minus 1.6MHz. The received frequency then ranges from 10.188MHz to 9.138MHz (the car radio will tune backwards in this instance).

By tuning the front-end circuits to the "high" side, it will tune from 11.288-12.33MHz, the 25-metre shortwave segment. A BFO (beat frequency oscillator) based on transistor Q4 gives very stable SSB reception, with the tuning rate remaining identical for all bands.

The BFO uses a standard wound IF coil, the frequency being the same as the car radio being used; commonly 262kHz, 455kHz or more recently, 450kHz.

The RF amplifier and mixer stages use dual-gate Mosfets Q1 & Q2. These are still available but now come in surface-mount packaging.

The coils are wound on standard 10mm coil formers and cans. The varicaps can be any "hyper-ubrupt" type with a tuning range of about 30-300pF with a 9V swing from potentiometer VR2. Defunct digitally-tuned car radios are a very good source for these and they are also available new.

Set-up simply requires the two RF coils to be brought into line and the BFO level trimmed to suit the radio being used. The frequency is adjusted to sit in the middle of the IF passband and the level set to adequately decode SSB.

Ideally the analog radio should have very smooth-tuning with no backlash (the tuning rate is exactly as it is when used for the AM broadcast band). This makes tuning SSB easy.

A slight improvement to the car radio's IF bandwidth can usually be achieved by peaking the IF strip, as these are commonly stagger-tuned for better fidelity.

The prototype used an old AWA Clarion car radio with a 262kHz IF strip. This gave really excellent results on SSB. The sensitivity is a few microvolts and stability is really good, the converter remaining on the aircraft net for days without retuning! The received frequency is 550kHz to 1.6MHz plus or minus the crystal frequency.

Dayle Edwards,
Westland, NZ. ($60)

Contribute And Choose Your Prize

As you can see, we pay good money for each of the "Circuit Notebook" items published in SILICON CHIP. But now there are four more reasons to send in your circuit idea. Each month, at the discretion of the Editor, the best contribution published will entitle the author to choose a prize: either an LCR40 LCR meter, a DCA55 Semiconductor Component Analyser, an ESR60 Equivalent Series Resistance Analyser or an SCR100 Thyristor & Triac Analyser, each with the compliments of Peak Electronic Design Ltd

www.peakelec.co.uk

So now you have even more reasons to send that brilliant circuit in. Send it to SILICON CHIP and you could be a winner.

You can either email your idea to **silchip@siliconchip.com.au** or post it to PO Box 139, Collaroy, NSW 2097.

Temwell World expert-customized any UHF.SMF BP Filter for mixer

Total Solution: F-cable, DVB-T Broadcast, WL networking Equipment etc.

"Any Fo, BandPass (BW, 3/4/5 tuning can be customized"

Temwell Innovative CD -20ns 3&4 tuning BP Filter

BW (-3dB) 60~160MHz; UHF Fo: 220~1.3G
IL 1.0~1.5dB; Group Delay:10~20 nsec

Pass Band	3 Tuning (3T) series P/No-Fo-BW	I.L. (dB)	4 Tuning (4T) series P/No-Fo-BW	I.L. (dB)
215~270M	TT6786S8-270M-60M	1.0	TF6435B-240M-60M	1.5
278~310M	TT6322S8-286M-60M	1.0	TF6422S8-286M-80M	1.5
311~355M	TT6786S8-330M-80M	1.0	TF6986S8-330M-80M	1.5
365~403M	TT6334S8-375M-100M	1.0	TF6434B-375M-100M	1.5
401~455M	TT6358F~450M~120M	1.0	TF6421H-450M~110M	1.5
456~515M	TT6333F~480M~120M	1.0	TF6432S~480M~120M	1.5
510~559M	TT6335F~530M~120M	1.0	TF6435F~530M~120M	1.5
556~595M	TT6333F~575M~120M	1.0	TF6433H~575M~120M	1.5
586~640M	TT6781F~620M~120M	1.5	TF6961F~625M~120M	1.5
661~700M	TT6333F~666M~150M	1.0	TF6433F~666M~120M	1.5
701~750M	TT6333T~725M~120M	1.0	TF6433T~725M~120M	1.5
681~830M	TT6334F~695M~140M	1.0	TF6434F~695M~140M	1.5
831~860M	TT6785F~850M~160M	1.0	TF6585F~850M~100M	1.5
861~900M	TT6335S~900M~150M	1.0	TF6435S~900M~150M	1.5
901~930M	TT6788T8-925M~120M	1.0	TF6988T8-925M~120M	1.5
931~959M	TT6786B-933M~120M	1.0	TF6986B-933M~120M	1.5
951~979M	TT6786Q8-975M~120M	1.0	TF6986Q8~995.5M~110M	1.5
976~1000M	TT6333M~980M~120M	1.0	TF6433M~980M~120M	1.5
1001~1100M	TT6789A8~1075M~120M	1.0	TF6989A8~1075M~120M	1.5
1101~1183M	TT6339F~1150M~120M	1.0	TF6439F~1150M~120M	1.5
1251~1300M	TT6392F7~1300M~200M	1.0	TF6e92F~1300M~200M	1.5

Temwell Innovative CD -40ns 3&4 tuning BP Filter

BW (-3dB) 40~60MHz; UHF Fo: 210~1.3G
IL 1.5~2.5dB; Group Delay:30~40 nsec

Pass Band	3 Tuning (3T) series P/No-Fo-BW	I.L.	4 Tuning (4T) series P/No-Fo-BW	I.L.
221~245M	TT6336B-240M~40M	2.0	TF6952J8-240M~60M	1.5
246~270M	TT6727B7-250M~30M	2.5	TF6437T8-248M~50M	1.5
276~315M	TT6727J8-295M~40M	2.0	TF6420B-315M~50M	1.5
356~400M	TT6727Q8-378M~40M	2.0	TF6972B8-378M~40M	2.0
401~455M	TT6727D8-428M~40M	2.0	TF6420B8-455M~50M	2.0
456~515M	TT6761I18-485M~40M	2.0	TF6972F~470M45M	2.0
516~555M	TT6781Z8-535M~40M	2.0	TF6935T8-535M~40M	2.5
556~595M	TT6775Q5-585M~40M	2.0	TF6962D8-585M~40M	2.5
596~640M	TT6782K8-630M~40M	2.0	TF6963F~660M~58M	2.5
661~700M	TT6332B8-695M~40M	2.0	TF6432T~695M~58M	2.5
701~750M	TT6730A~730M~40M	2.5	TF6965D8-735M~55M	2.5
751~800M	TT6797B~775M~52M	2.0	TF6965B~775M~55M	2.0
801~830M	TT6784A8-815M~40M	2.0	TF6963B1-825M~55M	2.5
831~880M	TT6751K6-852M~70M	3.0	TF6437T1F-845M~70M	2.5
881~900M	TT6780B8-880M~40M	2.5	TF6954E~895.5M~55M	3.0
901~930M	TT6784A4-915M~50M	2.5	TF6965H~927M~60M	3.0
931~959M	TT6780B8-940M~40M	2.5	TF6421A~959M~50M	3.0
951~979M	TT6780B8-965M~40M	2.5	TF6954A2~980M~60M	3.0
976~1000M	TT6780B8-988M~60M	2.5	TF6952Z~1000M~80M	3.5
1001~1100M	TT6734L8~1030M~77M	2.0	TF6734A~1030M~77M	2.5
1101~1180M	TT6732E7~1150M~70M	2.5	TF6953M~1140M~140M	3.5
1181~1250M	TT6780B8~1215M~60M	2.5	TF6983B8~1215M~60M	3.0
1251~1350M	TT6394B~1290M~150M	2.5	TF6943M5~1280M~100M	3.0

Temwell Innovative CD -50ns 3&4 tuning BP Filter

BW (-3dB): 20~40MHz; UHF Fo: 210~1.3G
IL 3.0~5.0dB; Group Delay: 40~50 nsec
5 tuning or New Fo Customized is accepted

Pass Band	3 Tuning (7H3 series) Temwell-P/N-Fo-BW	IL	4 Tuning (7H4 series) Temwell-P/N-Fo-BW	IL
221~245M	TT6786A~250M~30M	2.0	TF6518A~250M~30M	2.5
246~275M	TT6784K8~260M~20M	2.0	TF6427E~270M~30M	2.0
276~311M	TT6785T8~293M~20M	2.5	TF6967B~293M~30M	2.0
356~400M	TT7071E2~368M~20M	2.5	TF6422B~370M~30M	2.5
401~455M	TT6728E~463.5M~25M	2.5	TF6929B5~427.5M~32M	2.5
456~515M	TT6139B~477.5M~24M	2.5	TF6424T~485M~35M	2.5
516~555M	TT6777S~550M~25M	2.5	TF6930A~530M~28M	2.5
556~595M	TT6778D~585M~30M	2.5	TF6964B~575M~30M	3.0
596~640M	TT6779D~620M~22M	3.0	TF6432E~666M~38M	2.5
661~700M	TT6332S~666M~25M	2.5	TF6947D2~670M~35M	3.0
701~750M	TT6784B~725M~25M	3.0	TF6964F~705M~28M	3.5
751~800M	TT6784A~787M~25M	3.0	TF6931A~815M~26M	3.5
801~830M	TT6784A~813.5M~25M	3.0	TF6945A~835.5M~25M	3.5
831~880M	TT6721A~856.5M~30M	3.5	TF6931A~915M~38M	3.5
901~930M	TT6745T~881.5M~29M	3.0	TF6930A~900M~30M	4.0
931~930M	TT6750E~902.5M~27M	3.0	TF6929A~915M~58M	4.0
931~950M	TT6751A2~940M~30M	3.0	TF6929A~947M~40M	3.0
951~979M	TT6726K~960M~34M	2.5	TF6926B~960M~40M	3.5
976~1000M	TT6726TA~980M~35M	3.0	TF6947TA1~1015M~25M	4.0
1001~1100M	TT6740A~1040M~32M	3.0	TF6947TA~1015M~25M	4.0
1101~1180M	TT6739A~1150M~44M	3.0	TF6933B~1170M~35M	5.5
1181~1250M	TT6788B~1215M~35M	3.5	TF6966QD~1283.7M~25M	5.5
1251~1300M	TT6778B8~1270M~35M	3.0	TF6942B6~1290M~20M	5.0

See more SWS Part+Spec: www.temwell.com.tw

A.Customized Division: Joe@temwell.com.tw
B. Mail Order Division: Sales@temwell.com.tw
Standard Filter 200K In-Stock, 72 hr Delivery
~Welcome reseller~
www.temwell.com.tw / Mail: info@temwell.com.tw
Made in Taiwan / Designer & Manufacturer & Exporter
TEMWELL CORPORATION
ISO9001:2008 | RoHS | SAW Filter's Conjugation

siliconchip.com.au

A high-quality DAB+ tuner to build

Last month, we introduced our new DAB+/FM Stereo Tuner and gave the circuit details. This month, we show you how to assemble the two PC boards and install them into a low-profile steel case.

IF YOU WANT TO BUILD this project, there's just one way to go – buy the complete kit from Jaycar Electronics (see panel).

There are several reasons for this. First, the Venice 7 radio module is not readily available from other sources. Second, the main PC board supplied with the kit will have the surface-mount dsPIC microcontroller (IC1) already soldered in place (and pre-programmed). And third, the Jaycar kit will come with a pre-punched custom steel case with screened lettering to give the unit a professional finish.

Having the microcontroller already soldered in place is a real bonus. It will save you the hassle of having to solder this part in by hand and risk ruining the main board.

The DAB+/FM Stereo Tuner will take you quite a few hours to build, so it's best to tackle it in stages. There are two PC boards to build: (1) a main board which carries the Venice 7 module, the microcontroller, the power supply components and several input/output connectors; and (2) a front panel board which carries the LCD, switches, rotary encoder and the IR receiver.

You will need only a few basic tools

Where To Buy A Kit Of Parts

A kit of parts for the DAB+/FM Tuner will be available from Jaycar Electronics – Cat. KC5491. This kit will be complete and will include the Venice 7 radio module, double-sided plated-through PC boards, a pre-punched custom steel case with screened lettering and the remote control. The main board will be supplied with the dsPIC microcontroller (IC1) soldered in place.

Kits will be available by early December and can be pre-ordered at your local Jaycar store.

Pt.2: By MAURO GRASSI

to build the tuner – a soldering iron (preferably a temperature-controlled type) with a fine tip, a pair of needle-nose pliers, a pair of side cutters and an Allen key. A DMM (digital multimeter) is also necessary.

Main board assembly

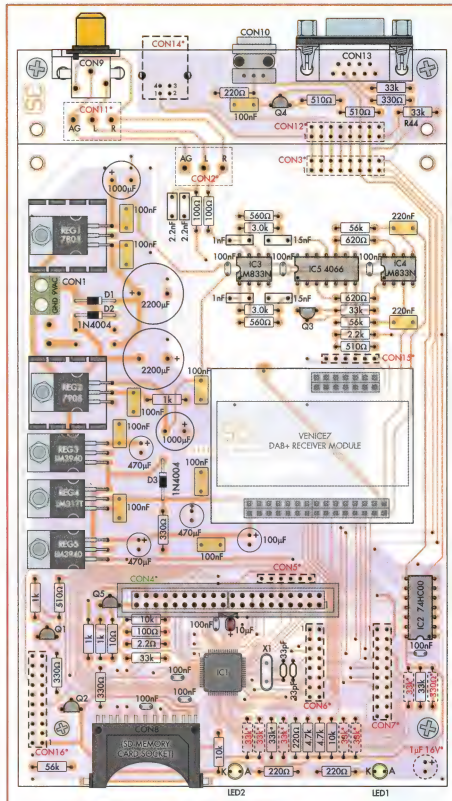
We'll begin with the main board assembly. This double-sided board is coded 01110101 and measures 113 x 194mm. As mentioned, it's supplied with IC1 already soldered into place and should be carefully inspected for defects before proceeding.

Refer now to Fig.3 for the main board parts layout. Begin the assembly by installing the resistors, taking care to fit the correct value at each location. Table 2 shows the resistor colour codes but we strongly advise that you check each one using a DMM before installing it.

Follow these with the three 1N4004 diodes (D1-D3). These must go in with their striped ends orientated as shown. The four IC sockets (for IC2-IC5) can then go in with their notched ends matching the board layout.

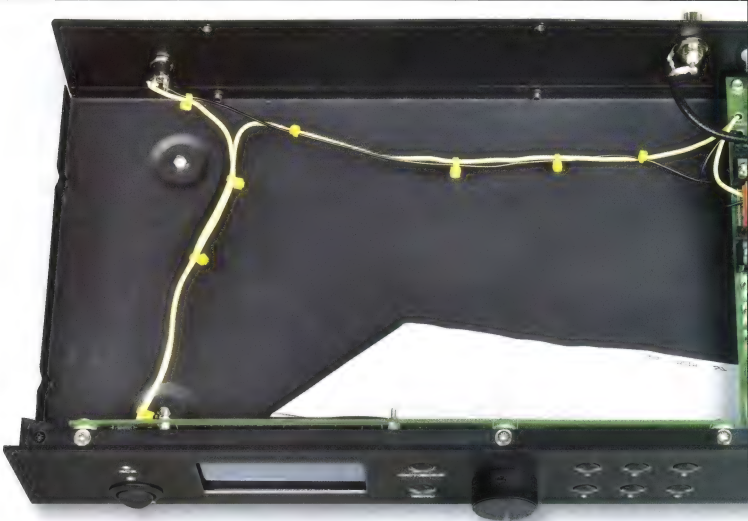
Follow these with the ceramic, monolithic, MKT and electrolytic capacitors, in that order. Make sure the electrolytic capacitors go in the correct way around and note that some of the 100nF capacitors are MKT types (around the regulators and op amps) while the others are monolithic types (around IC1 and IC2).

Note also that some 100nF monolithic capacitors have a lead spacing of 0.1-inch (2.54mm) whereas others have a 0.2-inch (5.08mm) spacing. The PC board uses 0.1-inch spacing so if the



* INSTALL CON4 ON REAR OF PC BOARD WITH KEY SLOT TOWARDS IC1
* DO NOT INSTALL – MAY BE USED FOR FUTURE EXPANSION

Fig.3: install the parts on the main PC board as shown here. Make sure that all polarised parts are correctly oriented and note that CON4 is installed on the rear of the board with its keyway towards IC1.



The completed main board assembly is installed at the righthand end of the chassis. Leave the Venice 7 module and ICs2-5 out until after the initial power supply checks have been completed (see text).

Table 1: Capacitor Codes

Value	µF Value	IEC Code	EIA Code
100nF	0.1µF	100n	104
15nF	.015µF	15n	153
2.2nF	.0022µF	2n2	222
1nF	.001µF	1n	102
33pF	NA	33p	33

capacitors supplied are 0.2-inch types, you will have to bend their leads with needle nose pliers to make them fit.

Next, install the 2-way screw terminal block for CON1. CON 2 & CON11 are 3-way screw terminal blocks but it's not necessary to install these (or any other parts marked with a red asterisk) and they are not included in the kit. If fitted, they give on-board access to the two stereo audio outputs, which may be useful for a future modification.

The BC337 NPN transistor (Q1) can be installed next, followed by the three BC327 PNP transistors (Q2-Q4). These transistors must go in the right way around. Push them down onto the board as far as they will comfortably go (but don't over-stress the leads) before soldering them into place.

Follow these parts with the 2N7000 FET (Q5), the 7.3728MHz crystal (X1) and the two 3mm LEDs (LED1 & LED2). The latter must be correctly orientated (see Fig.3) and are installed so that they sit flush with the surface of the PC board.

Installing the regulators

The five 3-terminal regulators (REG1-REG5) are next on the list. As shown in Fig.3, these are all installed with their metal tabs flat against the PC board. This is done by first bending their leads down through 90° about 5mm from their bodies and then securing them to the PC board using M3 x 6mm machine screws, flat washers and nuts.

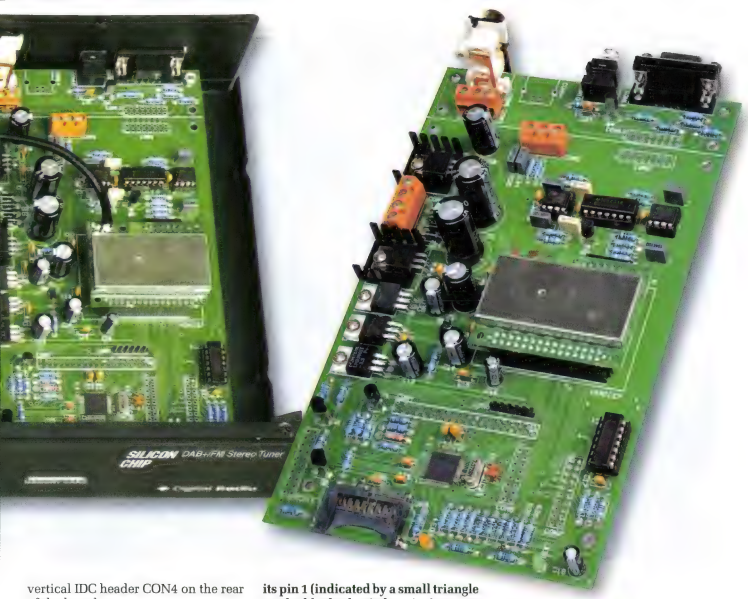
Note that REG1 & REG2 must be fitted with mini heatsinks under their tabs but these are not necessary for REG3-REG5.

Tighten the mounting screws down firmly before soldering the regulator leads to the board. Don't solder the leads first, otherwise the solder joints and PC board tracks may fracture when the screws are tightened.

Sockets & connectors

Two 7-pin female header strips can now be installed to make up the 14-pin (ie, 2 x 7-way) socket for the Venice 7 module. Once these are in, use 2 x 7-pin and 2 x 8-pin strips to make up the 30-way socket for the other side of the module. These 14-way and 30-way sockets allow the Venice 7 module to be easily removed later on, if required.

The connectors can now be installed along the rear edge. This involves fitting the stereo RCA connector (CON9), the TOSLINK transmitter (CON10) and the DB9 serial port (CON13). Once these are in, install the 40-way



vertical IDC header CON4 on the rear of the board.

It's important that CON4 be orientated correctly. It must be installed with its key slot towards IC1, so that its pin 1 (indicated by a small triangle on the black plastic housing) goes to the square pad.

The memory card socket (CON8) is next on the list. This is a surface-mount socket and is mounted on the top of the board.

Begin by positioning the memory

Table 2: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	3	56kΩ	green blue orange brown	green blue black red brown
❑	6	33kΩ	orange orange orange brown	orange orange black red brown
❑	3	10kΩ	brown black orange brown	brown black black red brown
❑	2	4.7kΩ	yellow violet red brown	yellow violet black brown brown
❑	2	3kΩ	orange black red brown	orange black black brown brown
❑	1	2.2kΩ	red red red brown	red red black brown brown
❑	6	1kΩ	brown black red brown	brown black black brown brown
❑	2	620Ω	blue red brown brown	blue red black black brown
❑	2	560Ω	green blue brown brown	green blue black black brown
❑	4	510Ω	green brown brown brown	green brown black black brown
❑	6	330Ω	orange orange brown brown	orange orange black black brown
❑	4	220Ω	red red brown brown	red red black black brown
❑	4	100Ω	brown black brown brown	brown black black black brown
❑	1	10Ω	brown black black brown	brown black black gold brown
❑	1	2.2Ω	red red gold brown	red red black silver brown

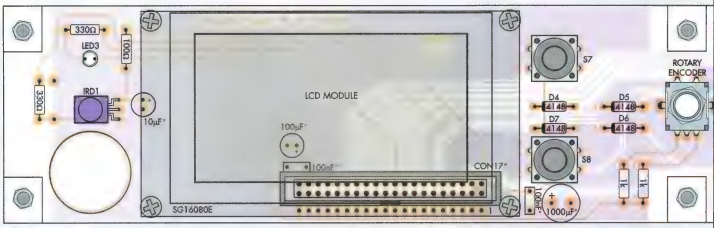
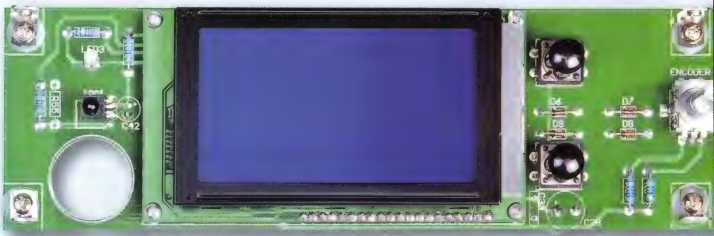
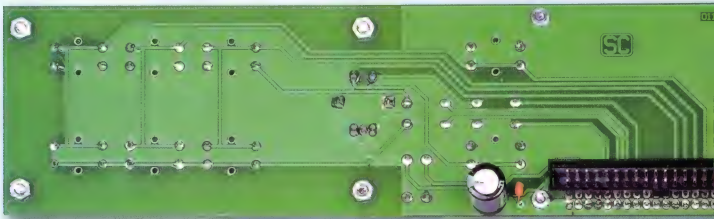


Fig.4: follow this diagram to install the parts on the front panel PC board. Note that the IDC header (CON17) and all five capacitors are mounted on the rear of the PC board (see photo below).



This is the fully-completed front panel board, with the switch caps installed and the L-brackets mounted in position. Be sure to align IRD1's lens vertically with LED3 and with its domed top 11mm above the board, as described in the text.



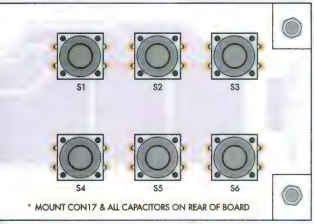
This rear view of the display board shows how the IDC header and capacitors are installed. Be sure to install the IDC header with its key-slot towards the bottom edge of the board.

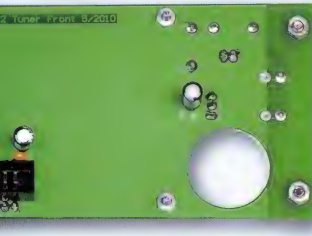
card socket so that its two plastic locating pins fit into two matching holes in the PC board. That done, use some sticky tape to hold it in place while you solder the two metal tabs on the sides of the connector. The tape can then be removed and the remaining 13 terminals carefully soldered to their respective pads. Take care with these and avoid touching the plastic connector with the soldering tip.

Venice 7 module

The Venice 7 module connects to the main board via 30-way and 14-way pin headers. It's supplied with the 30-pin (2 x 15-way) header already in place but you will have fit the 14-pin (2 x 7-way) pin header yourself.

To do this, first cut a 2 x 7-way header from the supplied 2 x 20-way header using side cutters. The 2 x 7way header can then be carefully soldered to the Venice 7 module (see photo).

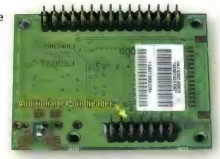




That completes the assembly of the main board apart from installing the Venice 7 module itself and fitting ICs2-5. Leave these parts out for the time being.

Front panel board assembly

Like the main board, the front panel board is double-sided with plated through holes. It is coded 01110102 and measures 277 x 57mm.



The Venice 7 module comes with a 30-pin header already in place but you have to also solder in a 14-pin header (near the opposite edge) yourself.

As usual, begin by carefully inspecting the PC board for hairline cracks or unintended shorts between nearby tracks (use a magnifying glass if necessary). Manufacturing defects are rare but possible and it is much easier to spot any problems before the parts have been installed.

Fig.4 shows the parts layout. Start the assembly by installing the resistors, then install the four 1N4148 signal diodes (D4-D7). Make sure that the latter are orientated correctly, ie, with their cathodes to the left. **The capacitors can be installed next. These must all be installed on the rear of the PC board – see photo. Make sure that the three electrolytic capacitors go in with the correct orientation.**

The eight pushbutton switches and the rotary encoder are next on the list. These parts will only fit the right way around. Be sure to push the plastic locating pins on the pushbuttons into their corresponding holes so that the switches sit flush against the board and are straight.

The blue LED (LED3) can now be fitted. It must be correctly orientated and installed so that the top of its lens sits 14mm above the board. This can be done by inserting a 9mm cardboard spacer between its leads and pushing the LED all the way down onto this before soldering.

Follow with the infrared receiver (IRD1). This goes in with its leads bent down by 90° and its domed lens facing upwards (so that it will later face the front panel). Adjust IRD1 so that the top of the lens is 11mm above the board surface and is vertically aligned with LED3 before soldering its leads.

All that remains now is to install the 40-pin IDC header and mount the LCD module. **This header goes on the rear of the board (see photo) and must be orientated so that its keyed slot is towards the bottom edge of the board – see Fig.4.**

Mounting the LCD

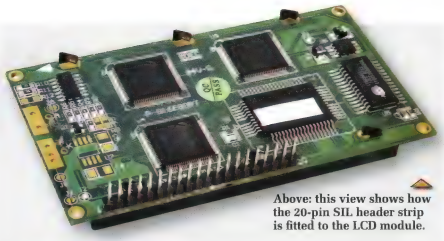
Now for the LCD. This must first be fitted with a 20-pin header strip, obtained by cutting eight pins off the supplied 28-pin strip. This can easily be done using side cutters.

Solder the 20-pin strip into place, then mount the LCD module on the PC board as shown in Fig.5. Note that two M2 nuts are fitted between the LCD module and the board at each corner location, to provide a 3mm spacing between the two.

Note also that you will have to file away a small section of the head of one of the four mounting screws so that it clears the LED backlight assembly installed inside the LCD module. This is the screw that fits in the top right corner when viewing the LCD module in the normal orientation.

In addition, it may be necessary to file a small notch in bottom-left corner of the IDC socket (as viewed from the back of the board) to clear the adjacent mounting nut.

Tighten the assembly down firmly, then solder the 20 header pins from the LCD module to the display board. Work quickly



Above: this view shows how the 20-pin SIL header strip is fitted to the LCD module.

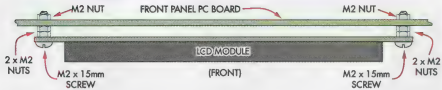


Fig.5: the LCD module is attached to the front panel board using M2 x 15mm machine screws and nuts, with additional M2 nuts (ie, two at each corner) used as spacers.

during this procedure and do not apply heat to any pin for more than five seconds.

The front panel board assembly is now complete except for the switch caps. These are best left off until the board is mounted in the case, so that they don't get lost.

Mounting the main board

The two PC board assemblies can now be installed in the metal case. As mentioned earlier, the Jaycar kit will come with a pre-punched case with screened lettering on the front and rear panels. This makes the final assembly easy, since you don't have to drill any holes.

Figs.6 & 10 shows the mounting details for the main board. It sits on stacked M3 x 10mm metal spacers in the righthand section of the case.

The first step is to secure the stacked spacers to the bottom of the case using M3 x 16mm countersink head (CSK) screws – see Fig.6. That done, fold the 40-way IDC cable at right angles exactly as shown in Fig.7 (note the position of the lead with the red stripe).

Check the cable carefully against Fig.7, then plug the righthand header into CON4 on the underside of the main board. The lead with the red stripe should go to pin 1 of the board header – see Fig.3. You should find that the IDC cable emerges from the lefthand side of the main board under transistor Q2 and the vacant holes for CON16.

Important: if the headers on the supplied IDC cable do not have a key (to match the key slot in the board header), then make sure that the side with the red stripe goes to pin 1 of the board header. This pin is indicated on the parts layout diagram (Fig.3) and is also adjacent to a small triangle on the plastic body of the header.

The main board can now be mounted on top of the stacked spacers and secured using four M3 x 5mm machine screws (black). Check that the connectors at the rear are correctly centred in their rear panel cut-outs before tightening the screws down.

Front panel board mounting

This board is attached to the top and bottom rails on the back of the front panel using six L-shaped metal brackets. Before fitting the board though, you will need to remove the front panel from the case by undoing the screws at either end and along the bottom edge.

Each L-bracket has one M3 tapped hole and one untapped hole. Fig.8 shows how they are attached to the display board using M3 x 10mm countersink (CSK) head machine screws and nuts into the untapped holes. **Note that a flat Nylon washer is fitted between each L-bracket and the PC board.**

Be sure to adjust each bracket so that it sits square with the PC board before tightening its mounting screw (see photo). This is necessary so that they later line up with the mounting holes in the front-panel rails. A couple of test fittings may be necessary before you get them exactly right.

Before finally mounting the front panel board, it's a good idea to fit the power switch. This should be orientated so that it is ON when the rocker is down and this can be determined by checking it with a multimeter (set to Ohms). In practice, this means that it goes in with the contact that's closest to the edge towards the top (ours is in the wrong way around).

Once the switch is in place, slip the front panel board assembly into position and secure it to the front panel using six M3 x 10mm countersink (CSK) head screws. These go through the top and bottom rails and into the tapped holes of the L-brackets. The completed assembly can then be re-fitted to the case and the knob attached to the shaft of the rotary encoder.

You will need an Allen key to tighten the small grub screw inside the

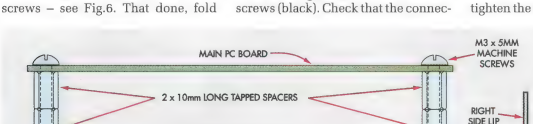


Fig.6: the main PC board is mounted on stacked M3 x 10mm spacers and secured using M3 x 16mm CSK machine screws from underneath and M3 x 5mm screws through the top.

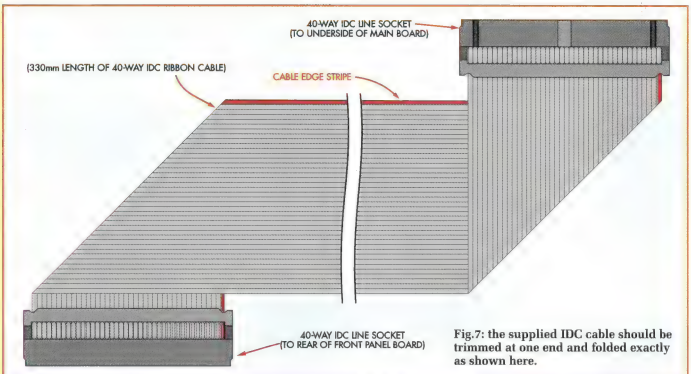


Fig.7: the supplied IDC cable should be trimmed at one end and folded exactly as shown here.

knob (align it so that the grub screw tightens against the flat section of the "D" shaped shaft).

Now check that there is sufficient clearance between the knob and the front panel when the rotary encoder is pressed. Provided you've mounted the front panel board correctly, it should be OK with the knob pushed all the way onto the rotary encoder's shaft.

Power supply wiring

The next step is to install the power socket on the rear panel and run the supply wiring – see Fig.10.

As shown, the sleeve terminal of the power socket (which connects internally to chassis) goes directly to the GND terminal of CON1. This lead can be run using a 340mm length of black medium-duty hook-up wire. Note how the wire is threaded through a spare hole near the edge of the main PC board, to help anchor it.

The centre terminal of the power connector is connected to the power switch using a 210mm length of yellow hook-up wire. A third yellow lead (360mm-long) is then run from the remaining switch terminal and is looped through another anchor hole before finally connecting to the 9VAC input of CON1.

Eight small cable ties should now be fitted to secure the supply wiring in place. These not only keep the wiring tidy but also prevent the leads from moving and coming adrift at the terminals.

Preliminary checks

With construction virtually complete, you now have to make a few preliminary checks on the power supply before installing the Venice 7 module and ICs2-5. These checks should also be made before plugging the IDC header into the front panel board.

The step-by-step procedure is as follows:

Step 1: check that the Venice 7 module and ICs2-5 are all out of circuit. Check also that the IDC header to the front panel board is unplugged.

Step 2: with the lid of the case off, connect a 9V 500mA AC plugpack and apply power while observing LEDs 1 & 2 on the main board. LED1 should light and stay on, while LED2 should light only briefly. If they don't, switch off immediately and check the supply wiring and the regulator circuitry on the main board.

Step 3: if Step 2 checks out, check the output voltage of the LM317T regulator (REG5) with respect to GND. It should measure close to 1.2V. Similarly, check the output voltages from the two LM3940 regulators (REG3 & REG4) – they should both measure close to +3.3V.

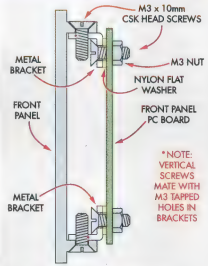


Fig.8: here's how to attach the L-brackets to the front panel board and secure the assembly to the top and bottom rails that run along the back of the front panel.

If any of these voltages are incorrect, switch off immediately and locate the cause of the problem.

Step 4: check the outputs of the 7805 and 7905 regulators – they should measure close to +5V and -5V respectively. If they do, all is well and you can proceed. If not, switch off and clear the fault before proceeding.

Note: when making these voltage checks, check the pin-out diagrams for the regulators as shown in the cir-

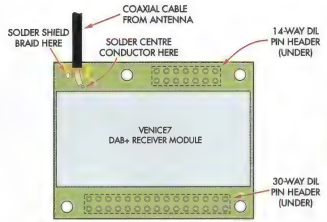


Fig.9: the centre conductor of the coax cable from the antenna socket must be soldered to the Venice 7 module in the exact location shown here.

cuit diagram (Fig.1) in Pt.1. The pin-outs differ from regulator to regulator, so don't get caught out here.

Final assembly

With the power supply checks complete, it's time for the final assembly. This must be done with the power off, so disconnect the plugpack supply for the time being.

The antenna socket can now be fitted to the rear panel. Secure it by tightening down the nut firmly, then connect a 100mm length of 75Ω RG59 cable to it – see Fig.10. As shown, the shield wire must be twisted into a lead and soldered to the earth lug. Keep the stripped leads of the coaxial cable as short as possible, to avoid degrading the sensitivity.

Once that's done, solder the other end of the 75Ω coax cable to the Venice 7 module's antenna terminals as shown on Fig.9. **Note that there are two separate antenna inputs on the module – one for Band 3 (VHF) and the other for L-band.**

Band 3 is the most commonly used and is correct for Australia. It's simply a matter of soldering the inner conductor of the antenna cable to the pad in the exact position indicated on Fig.9, while the shield is soldered to one of two nearby gold-plated earth pads.

The Venice 7 module can then be plugged into the main PC board.

Finally, plug in ICs2-5, connect the IDC header to the front panel board and fit the black plastic caps to the eight pushbutton switches. Be sure to orientate the ICs correctly and don't get the two 14-pin types mixed up. In addition, make sure that the red-striped lead on the IDC cable goes to pin 1 of the header, as shown on Fig.10.

These switch caps are simply pushed into place. If you like, you can apply a small amount of glue inside the caps before fitting them although this shouldn't really be necessary.

Final testing

Now for the final test. Apply power

This view shows the rear-panel layout of the DAB+/FM Stereo Tuner and also shows how the display board is mounted on the back of the front panel.

to the tuner and check that the LCD lights up. It should display the SILICON CHIP logo for about three seconds (see photo) and then give a warning stating that no digital or FM stations have been programmed in. It should then default to 104.1MHz in FM mode.

Assuming this is correct, switch off and attach the lid to the case, securing it using the seven supplied M4 x 6mm screws (three along the top and two at either end).

Next month

That completes the assembly of the unit. Next month, we'll explain the initial set-up and give detailed instructions on how to operate it. SC

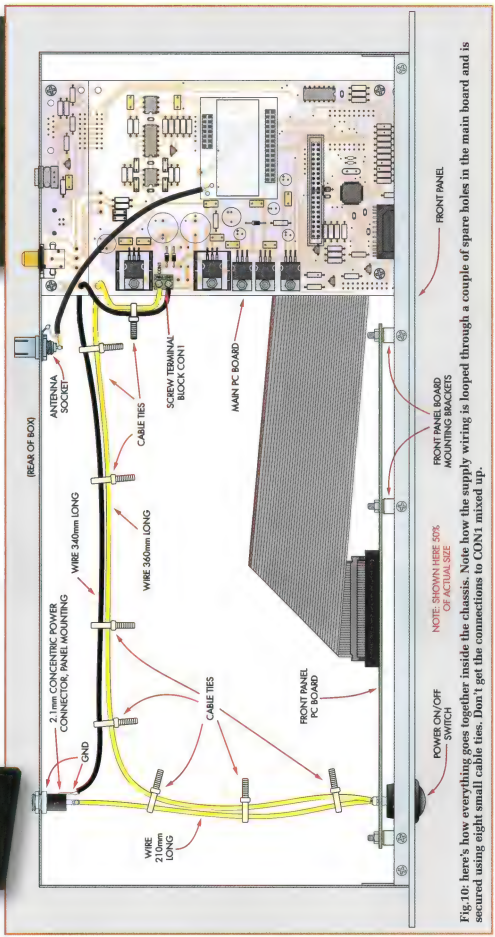


Fig.10: here's how everything goes together inside the chassis. Note how the supply wiring is looped through a couple of spare holes in the main board and is secured using eight small cable ties. Don't get the connections to CON1 mixed up.

Ultrasonic anti-fouling for boats

By LEO SIMPSON

Part 2: encapsulating the transducer and installation

In the September issue we published the details of the ultrasonic driver for this project, which is housed in an IP65 case for safety and protection from water ingress. This month we describe how to encapsulate the ultrasonic transducer so that it is completely safe to handle. Once it is encapsulated it will operate reliably, even if it is submerged in the bilge of the boat. We also show a typical installation of the system in a large power boat.

Make no mistake. The drive voltage applied to the transducer in this project is enough to give you a severe electric shock.

I speak from painful experience here, having inadvertently touched the top of an exposed transducer while it was under test, prior to "potting".

In fact, the shock I received was solely due to my own body capacitance to earth, since I only touched part of the circuit with one finger.

If the total voltage had been applied across both my arms, for example, I might not have been here to write the second part of this article. So you have been warned!

THIS PROJECT IS POTENTIALLY LETHAL!

For that reason, we have come up with a very specific procedure for encapsulation of the transducer.

Please follow it exactly.

Preparation . . .

The first step is to obtain everything in the Bill of Materials, shown elsewhere in this article. We start with a standard plastic plumbing fitting, available from stores like Bunnings and plumbing outlets.

It is described as a "50mm BSP male valve socket". BSP stands for "British Standard Pipe" and you will find it is the same 50mm coarse thread as on the outlet pipe for your toilet cistern.

WARNING!

This circuit produces an output voltage of up to 800V peak-peak to drive the ultrasonic transducer and is capable of delivering a severe electric shock.

DO NOT touch the drive unit output terminals, the PC tracks leading to CON2 or the transducer terminals when power is applied.

To ensure safety, the PC board must be housed in the recommended plastic case, while the transducer must be correctly housed and fully encapsulated in resin as described here.

The largest outside diameter of the transducer is close to 44mm and therefore is a close fit inside the 48mm smaller inside diameter of the nominal 50mm male valve socket. The first step in the procedure is to:

Use a rasp or coarse file to create a flat on one side of the plastic fitting. This needs to be done to slightly reduce the wall thickness of the fitting so that we can mount an IP68 6.5mm cable gland on it.

Once the flat has been filed, you need to drill a 12mm hole in the centre of the flattened section to take the 6.5mm cable gland. When fitting the cable gland, you will also need to chamfer the plastic nut on two sides so that it takes up enough thread.

Pass a length of the 2-core black sheathed cable through the gland and strip the wires as shown in Photo 4. The length should be sufficient to be neatly routed from the mounting position of the ultrasonic driver to the

Bill of Materials – Encapsulated Transducer

1 piezoelectric transducer (Jaycar AU-5556)
1 black plastic flange washer (Hansen SBN50LB)
1 50mm BSP male valve socket (HR-P0175050 or Vinidex equivalent etc)
1 IP65 6.5mm cable gland (one of three required for the whole project)
~10 metres 2-core black flexible sheathed speaker cable (see text) [the same cable should be used for the DC input to the ultrasonic driver box. The exact amount will depend on the length of the boat] (eg Jaycar WB-1754)
1 small jar of petroleum jelly or Vaseline
1 40ml tube of non-hardening silicone grease (eg Fix-A-Tap waterproof lubricant)
1 piece of melamine-coated or Formica-coated pyneboard or MDF etc (say 150 x 200mm)
1 250g pack of 2-part polyurethane potting resin (Electrolube UR5097)
1 spray can silicone mould release (Electrolube DAS400)
1 pack of J-B Weld high temperature 2-part epoxy
5 1mm thick black plastic "spacers" (see text)
4 stainless steel self-tapping screws (to attach ultrasonic driver box to bulkhead in boat)
1 small piece of cling-wrap (say 150mm square)
1 piece of coarse grade sand/emery paper

Photo 1: before we get under way, here are the chemical products we're recommending. On the left is the Electrolube Polyurethane Potting Compound, with instructions and the Electrolube Silicone Mould Release. Centre is the Fix-A-Tap waterproof lubricant (available from hardware stores and pool shops) while on the right is the J-B Weld 2-part Epoxy Glue. It's not easy to get – but it works!

Photo 2: here we've filed a flat on one side of the 50mm BSP male valve socket and drilled a 12mm hole, both of which are needed to accommodate the 6.5mm cable gland through which the wires pass from the driver to the transducer.

Photo 3: Unfortunately, on the threaded end there were some moulding dags – we need the base perfectly flat so we trimmed these off with a sharp knife then smoothed it with some sandpaper.

Photo 4: next, we passed the end of the flexible 2-wire cable through this cable gland, leaving plenty of free wire on the inside. Leave the gable gland nuts loose at this stage to allow the cable to slip in and out.

Photo 5: the 6.5mm cable gland, when tightened up later, makes a completely waterproof entry point for the flexible cable from the driver unit. The recommended cable is double insulated but still highly flexible.

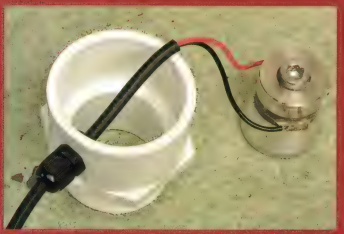


Photo 6: next we soldered the two bared ends of the cable to the lugs on the side of the transducer (disconnect from the driver unit first!) Make sure these solder joins are good'uns, because once potted, you won't be able to get at them!

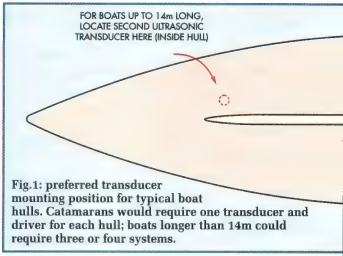


Fig.1: preferred transducer mounting position for typical boat hulls. Catamarans would require one transducer and driver for each hull; boats longer than 14m could require three or four systems.

planned mounting position of the transducer in the hull.

We suggest that you make the cable length at least 4 metres; perhaps more for a very large boat. You can always shorten it at the time of installation.

Solder the wires to the transducer, as shown in Photo 6.

When the transducer is positioned inside the plastic valve socket and finally encapsulated, we want the encapsulating material to be no more than 1mm thick over the face of the transducer – therefore the transducer needs to sit up 1mm above the bottom of the socket.

To achieve this, you will need to glue some pieces of black plastic 1mm thick to the face of the transducer. We used Loctite Glass adhesive which cures on exposure to daylight (ultraviolet).

We glued five pieces but four is probably enough. See Photo 7. These 1mm "spacers" ensure the right thickness of the encapsulation, as will become evident as we proceed.

Next, we work on the black plastic flange, ie, the "Hansen SBN50LB black plastic flange washer" to make a jig for the encapsulation process.

This flange is a standard unit used on plastic water tank installations and will eventually be used to secure the encapsulated transducer to the hull of your boat.

For now, we need to drill four 4mm holes to take 6G self-tapping screws, in the flange section. The flange is then attached to a piece of melamine-coated or otherwise sealed MDF or pyneboard. Before you do that, place a sheet of cling-wrap between the flange and the baseboard, as in Photo 8.

Note that the screws used to attach the black plastic flange will be re-used when the ultrasonic driver unit is installed in the hull of the boat.

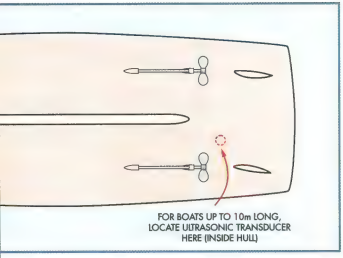
Having screwed the flange to the baseboard, spray inside the thread of the fitting and the cling wrap with Electrolube DAS400 silicone mould release, as shown in Photo 9.

Make sure the cling wrap is taut and has not become crinkled by the mould release spray.

Screw the male valve socket, with transducer attached by its leads, into the black plastic flange. Do not overtighten it. You now have a secure jig for the encapsulation process. The transducer should still be outside the valve socket, as shown in Photo 10.

It now becomes clear why we need the silicone mould

siliconchip.com.au



release spray. We need to be able to detach the flange from the transducer/valve socket after encapsulation is complete.

Mixing the potting compound

We now mix the encapsulating compound. This requires one 250g pack of Electrolube UR5097 2-part Polyurethane resin. It comes in a tough plastic pouch which is partitioned into two compartments for the resin and the hardener.

You need to remove the plastic fittings from the pouch and then merge the two syrupy liquids together. Knead and roll the bag around for several minutes to thoroughly mix the resin.

Follow the instructions on the pack – but we found mixing took quite a lot longer than the instructions specified (probably because it was a rather cold September day when we did it). But eventually we were happy with the mix – a consistency of runny grease.

Now pour a small amount of the mixed resin into the valve socket so that it covers the bottom surface by a few millimetres. Then insert the transducer face down into the valve socket and push it all the way down. Remember that we want the encapsulation on the face of the transducer to be only 1mm thick. If at all possible, make sure that the transducer has equal clearance all round, inside the valve socket. Photo 7 shows this clearly.

When you are sure that the transducer is correctly positioned, push the leads down so that they will be fully covered by the resin.

Then pour in more resin until its level is just below (say a millimetre or so) the lip of the valve socket. Do not fill it to the brim, otherwise it will overflow as it warms and expands slightly during the curing process.

Leave it overnight to cure. The ambient temperature should preferably be more than 15°C otherwise the curing process will take too long.

The cured resin is not really hard – it has some "give" if you press it with a finger-nail. When cured, remove the four screws holding the flange to the MDF and lift it off. It should come away easily.

You should be able to peel the cling-wrap off the face of the finished transducer, leaving a nice clean smooth surface. The finished transducer should look like that shown in Photos 15 and 16.

Photo 7: here you can clearly see the five 1mm bits of plastic we glued to the transducer surface to give clearance underneath for the potting compound when it is later poured in. The transducer should be a nice friction fit in the tube – we are just checking everything fits!

Photo 8: to make sure the potting mix doesn't stick to the base board, stretch some cling wrap underneath the flange. Remove any wrinkles or bubbles because you want the potting compound to be as smooth as possible. Note the four holes we drilled through the flange.

Photo 9: when you have screwed the flange onto the base board, spray some mould release onto the cling wrap and also onto the threads of the nut, again to make sure that the potting mix later lets go as it should. You'll probably find that the mould release causes the cling wrap to wrinkle a little – again, pull the cling wrap tight to make it smooth.

Photo 10: remove the transducer and screw the empty pipework into the nut. Make it firm, but not so tight that it bites into the cling wrap. You're now just about ready to pot the transducer so make one last check that your solder joints are perfect – once potted, it's very hard to remove !

Photo 11: the potting mix comes in a two-part pack which must first be combined and then thoroughly mixed before use. You needs to knead it! On a cool day, this can take quite a few minutes to do but if you don't mix completely, the compound may not cure properly.

Photo 12: once mixed, cut the corner of the bag off and pour just a small amount – say a couple of millimetres or so – into the transducer housing. Put the bag to one side for a moment (remember to keep the pouring hole up!).

Installation in the boat

There are two steps to the installation in a boat. First, determine the optimum position for, and install, the transducer and then similarly select the location for the ultrasonic driver unit and then install it.

The driver case needs to be mounted on a bulkhead or other position where it is unlikely to be splashed or immersed in any water which may be in the bilge. We will discuss installation of the transducer first.

Transducer location

As shown in the diagram of Fig.1, the encapsulated transducer must be installed inside the hull, near the running gear (ie, propellers and rudders). On the boat shown in the photos, the transducer was installed in the lazarette, under the floor of the transom. First, you must find a suitable flat section of the hull and on many boats, this will not be easy. Try positioning the black plastic flange (ie, without the transducer fitted) in a number of positions to get the best spot. Now let us go through the steps for installation.

With some coarse sandpaper and a sanding block, roughen the face of the black plastic flange, as in Photo 17. We want a good "key" for the epoxy resin.

Use the sandpaper and sanding block to thoroughly scour the hull position where the black flange is to be mounted. Photo 19 shows the plastic flange temporarily in position on the hull after it has been sanded.

By the way, it is essential that the mounting area for the flange must be clean and dry, and free from dust and grease. And of course, there should be no possibility of exposure to bilge water while the epoxy resin is curing.

Then mix a quantity of J-B Weld High Temperature 2-part epoxy resin. Do not use Araldite or any other epoxy mixes. We want to be sure of a reliable long-term bond to the hull which won't let go with constant ultrasonic vibration. See Photo 20.

Apply a liberal coating of petroleum jelly (or Vaseline) to the thread of the plastic flange, as in Photo 18. We don't want any epoxy resin to adhere to the threads otherwise the flange will not be usable.

Apply the mixed epoxy resin to the roughened surface of the flange, as in Photo 21. Then press it down onto the previously prepared section of the hull. Leave it to set for 24 hours. If the water (and therefore the hull) is very cold (eg, midwinter), leave it for longer.

Some adhesive will probably ooze out from under the flange – outside the flange it doesn't matter too much (apart from aesthetics). Inside, though, it should be carefully cleaned away without getting it on the threads so that the transducer (when fitted) will not sit proud of the hull.

Installing the driver unit

The next step is to install the ultrasonic driver unit. Its IP65 plastic case has provision for four mounting screws. To fit them, you need to remove the transparent lid of the case and position the unit in the spot where it is to be mounted. Preferably, it should be on a vertical bulkhead above the waterline, say between the engine compartment and the lazarette.

On the boat in the photos, this was not possible so it was positioned on the horizontal beam which carries

siliconchip.com.au

the hydraulic drive to the rudder (Photo 24).

It is most important that the ultrasonic driver unit be mounted above any likely spray or splashes from water in the bilge. On no account should you drill holes in the hull to mount the ultrasonic driver – that carries too much risk of you drilling right through the hull!

Photo 25 shows the ultrasonic driver being mounted in place. Use stainless steel screws – you can recycle those you earlier used to make the encapsulation jig.

Having mounted the ultrasonic driver in place, then position the encapsulated transducer next to the flange. Inevitably, this will involve running its cable through inaccessible holes in parts of the boat structure. If you can run the cable next to existing cable, so much the better. Lace the cable into position where necessary. It should not be allowed to flap about or hang in loose loops. Remember that boats experience severe vibration and we don't want the cable to fail in the long term (Photo 27).

You may have to drill holes in bulkheads to run the transducer cable through. Make sure those holes do not have rough edges which can chafe the cable. If they do, fit suitable grommets.

Meanwhile, back at the ~~ranch~~ hull . . .

Now that the J-B Weld has cured, we can return to the transducer mounting.

First, liberally coat the face of the encapsulated transducer with a non-hardening grease. We suggest "Fix-A-Tap" waterproof lubricant which can be readily obtained from hardware stores. This is applied to fill any voids when the transducer housing is screwed down into the flange.

Before screwing in the transducer housing (a conventional clockwise thread), twist the housing anticlockwise the same number of turns as it takes to screw it in so that when the transducer is installed, the cable is in its natural (untwisted) position. Do not over-tighten it but make sure that it is tight enough that it is not likely to shake loose over time.

Then make sure that the transducer cable is neatly routed and cannot possibly interfere with the operation of any moveable parts such as the rudder gear.

Finally, you need to make the supply connections to the house battery. Again, lace and anchor the supply cable securely. There is no need to fit an in-line fuse since there is already a 3A fuse on the PC board.

Note that since we are making a permanent connection to the battery, it must have a float charger or preferably, a 3-state charger so that it is always kept charged.

When power is applied, the green LED can be seen to be glowing through the transparent lid of the case.

Turn it on . . . and nothing!

You probably won't know that it's operating but if you want to check that the circuit is active, just position a portable AM radio next to the driver and you should hear it squealing away. As discussed in the FAQs (overleaf) there may be some who will hear a few clicks or whistles but these would be unusual.

OVERLEAF: Answers to the many questions we've already been asked about this system!

Photo 13: now push the transducer hard down, into the potting mix, face down. About now you might find out that overfilling with potting mix makes a nice mess of your thumbs . . . try to get the transducer as centrally located in the tube as possible, although it's not vital. Pull the cable back through the grommet until about 10mm of outer insulation is showing inside, then tighten the nuts.

Photo 14: squeeze the potting compound out like toothpaste – not too fast, to be sure you don't get any bubbles trapped. Fill to a millimetre or so below the top of the tube – as it cures, it warms and expands. We found we used most of the 250g pack of resin.

Photo 15: when cured and removed from the jig, this is what it will look like (hopefully without the air bubbles, although these won't affect operation). The top of the potting compound is just below the top of the fitting.

Photo 16: and here's what it looks like from the underside (the bit that contacts with the boat hull). The rough edge on the socket is actually a smooth edge – we removed some thread ends with sandpaper.

Photo 17: now we're moving onto the installation in the boat. After you remove the black plastic flange from your temporary jig, roughen the bottom with some coarse sandpaper. This is to give a good "key" for the adhesive to ensure it won't vibrate loose when fixed to the boat hull.

Photo 18: it's important that glue doesn't get into the thread, where it would clog it up. We smeared a good coating of Vaseline right around the threads – make sure it doesn't get on the bottom of the flange where you want the glue to take!

Ultrasonic Anti-Fouling FAQs

The first article on ultrasonic anti-fouling for boats has prompted a deluge of questions from readers who could not wait until the second article. So here are the answers.

Q: How big a boat?

A: The single transducer design and driver presented here is suitable for boats up to 10 metres long. Longer boats, say up to 14 metres, will require two transducers, each with its own driver unit. Boats bigger than 15 metres, say up to 20 metres, will require at least three and maybe four transducers and drivers.

Catamarans up to 10 metres long will require a separate transducer and driver unit for each hull.

Q: Do I need to cut a hole in the hull for the transducer?

A: Definitely not. The encapsulated transducer is mounted on a flat surface inside the hull. For a boat up to 10 metres, the transducer should be mounted near the running gear (ie, propellers & rudders) so that it offers maximum protection from marine growth.

Q: Is ultrasonic anti-fouling suitable for all boats?

A: Ultrasonic anti-fouling relies on one or more transducers mounted inside the hull to excite it at various frequencies in order to disrupt the cell structure of algae. It works well with metal hulls such as aluminium and with fibreglass hulls. It does not work with timber hulls as the timber is not a good conductor of ultrasonic energy. The same comment applies to ferro-cement or fibreglass hulls with a balsa sandwich or other composite construction (eg, closed-cell PVC foam).

Q: Does the ultrasonic anti-fouling unit present a risk of electric shock?

A: As stated in the circuit description, the ultrasonic transducer is driven with peak voltages up to 800V. If you make direct contact with the circuit or the ultrasonic transducer there is a very high probability that you will receive a severe electric shock. That is why the transducer itself must be completely encapsulated in a plastic fitting, as described elsewhere in this article.

Q: Is it necessary for the boat's hull to be cleaned of marine growth and conventionally anti-fouled before the ultrasonic anti-fouling system is installed?

A: Ultrasonic anti-fouling is unlikely to kill shell fish or molluscs already attached to the hull. Nor will it cause them to detach from the hull. Hence, there is no alternative to having the hull scraped and water-blasted to clean off all existing marine growth.

And if it is already on the slips for such cleaning and

other maintenance such as servicing outboard legs and replacing sacrificial anodes, it probably makes sense to have conventional anti-fouling paint applied, although this may be regarded as optional.

We should also emphasise that, no matter how effective ultrasonic anti-fouling may be in keeping the hull clean of marine growth, it will still be necessary to do regular maintenance such as the already mentioned servicing of outboard legs (in case of boats with inboard/outboard motors) and replacing sacrificial anodes.

Q: Will ultrasonic anti-fouling keep propellers, rudders and other "running gear" free of marine growth or is it still necessary to use anti-fouling compounds such as PropSpeed?

A: Ultrasonic anti-fouling should keep props and rudders free of marine growth. Overseas experience with commercial units has shown this to be the case.

Q: Does ultrasonic anti-fouling cause increased electrolytic leakage currents (electrolysis) and thereby increase corrosion on boats?

A: The ultrasonic transducer and driver unit are installed entirely within the hull of the boat and the ultrasonic transducer itself is transformer driven and is completely encapsulated to provide a high degree of insulation. There should be no leakage currents at all.

Q: Does ultrasonic anti-fouling harm fish or marine mammals?

A: This system causes no harm to fish or to marine mammals. Fish cannot hear it and while marine mammals certainly can perceive and respond to ultrasonic signals, they are not harmed in any way by the relatively low power levels which are likely to be radiated by the hull of the boat. Furthermore, the signal levels are much lower than those directly radiated by depth sounders and fish finders.

Q: Will I be able to hear the ultrasonic anti-fouling unit in operation, especially at night when the water is very still?

A: Unless you are a bat(!), you cannot hear ultrasonic frequencies directly. However, the transducer and the driving transformer do emit high frequencies and clicks at low levels. These are actually sub-harmonics of the

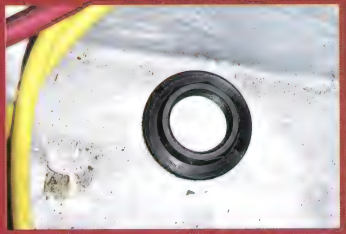


Photo 19: move the empty flange around the hull to determine the best transducer mounting position. When you're happy with your choice (see the text), roughen the fibreglass as you did the black flange – for the same reason. Here the flange is sitting in place but not yet glued.

Photo 20: did someone mention glue? We're recommending J-B Weld to secure the flange to the hull. It's not that easy to buy (try your local hardware store as distinct from the big chains) and it's not cheap – but it sticks like the proverbial.

Photo 21: apply a good layer of mixed glue all over the roughened base of the flange, again making sure you don't get any on the thread. You have quite a while before it starts to cure so take your time!

Photo 22: it's almost inevitable that there will be some J-B Weld oozing out from under the flange as you press it in place. The secret is to apply only as much pressure as is really needed to ensure the glue spreads right around, then wipe any excess off before it sets.

Photo 23: once set (24 hours +), the transducer assembly is screwed into position with a good big dollop of Vix-A-Vap lubricant on the face. But before doing so, wind it anti-clockwise a number of turns so that the cable ends up without loops or kinks. Screw down as hard as you can with your fingers but don't force it. Lace any loose cables

Photo 24: the location for the driver unit is just as important as the transducer. It must be one which can NEVER interfere with any boat operation and one which won't be stepped on if you need to get into the area. Just as importantly, it must be one which won't be swamped by bilge water, despite the IP65 case!

Ultrasonic Anti-Fouling FAQs

ultrasonic signals and are most evident as the frequencies are continuously shifted up and down over the operating spectrum.

However, once the unit is installed, you will only be able to hear these sounds, if at all, by placing your ear directly over the ultrasonic driver or over the transducer. You might also be able to feel some slight vibration of the transducer itself.

Q: Is ultrasonic anti-fouling equipment likely to cause damage to the hull of a boat, especially those of fibreglass construction? Will it cause osmosis or de-lamination?

A: We know of no research into this topic and while it could be suggested that the continuous, albeit low-power, ultrasonic vibration of the hull could lead to de-lamination, such ultrasonic vibration is extremely low in amplitude compared with the severe hull vibration caused by propellers and diesel or petrol motors when boats are operating at high power, especially when "on the plane". Furthermore, hulls are placed under very high stresses when boats are being pounded by heavy seas or are repeatedly slammed though waves or hitting wakes of other boats at speed.

Many older fibreglass boats, say more than 20 years old, are subject to osmosis and de-lamination. Repairs are routine but expensive to carry out and the boat must be out of the water for many months to ensure that any water trapped in hull laminations is removed.

If a boat was fitted with ultrasonic anti-fouling and after years of use, there is subsequent evidence of hull osmosis or de-lamination, it would be impossible to determine if it were caused by normal wear and tear or other causes.

Ultrasonic anti-fouling is routinely fitted to brand new boats but anyone contemplating such an installation would be wise to check that hull warranties are not invalidated. We make no warranties that ultrasonic anti-fouling does not cause hull damage.

Q: Will my boat batteries be damaged by the ultrasonic driver unit?

A: The ultrasonic driver circuitry described last month incorporates battery protection. If the battery is discharged to 11.5V, the circuit is disabled and will not resume operation until the battery is recharged.

However, since the ultrasonic anti-fouling driver is designed to operate continuously, the battery supplying it will need to be on permanent float charge. This will require 230VAC shore power if you are fortunate enough to have your boat in a pen or marina berth.

If your boat is on a swing mooring or is otherwise without shore power, then a solar panel and suitable

charger will be needed to keep the battery up to charge. We plan to publish a suitable solar charger with MPPT (maximum power point tracking) in a future issue.

Q: How big a solar panel will be required to keep the battery sufficiently charged?

A: The continuous power drain of the ultrasonic driver is about 3W or less, depending on the actual supply although the peak powers are much higher, at around 40W or more. To provide this level of power on a continuous basis you will need a solar panel installation of at least 20W. Many boats on swing moorings would already have such a solar panel but it would need to be augmented by at least another 20W to be sure that the battery is fully charged during periods of bad weather or in winter when there are less hours of sunlight.

Can the ultrasonic driver feed two or more transducers?

A: The ultrasonic driver presented here can definitely only drive one transducer. Connecting it to two transducers in parallel will overload both its transformer and the driving Mosfets. In addition, each transducer needs its own separate transformer to drive it, so that it can resonate independently of other transducers. This is necessary to obtain maximum efficiency from each transducer.

While it is certainly possible to produce a design with more than one transformer in order to drive two transducers (or three transformers to drive three transducers etc), the resulting design would require a much larger PC board and IP65 case. This would inevitably mean that it would be more difficult to mount in a boat since space is always at a premium.

In addition, in a larger boat installation, having multiple single ultrasonic drivers and transducers confers an extra degree of reliability with virtually no penalty in terms of battery drain.

Q: Will the ultrasonic anti-fouling cause interference to radio operation on my boat?

A: If you place a portable AM radio on top of the ultrasonic anti-fouling driver unit, you should be able to hear evidence of its operation as a continuously shifting squeal. However, at even small distances away from the driver, such interference should be negligible. No interference will be caused to marine radio communications or to broadcast FM or TV reception, or to digital TV or DAB+ reception.

Q: Will the ultrasonic anti-fouling unit interfere with the operation of depth sounders or fish finders?

A: No. SC

Photo 25: Use the case itself (with the lid off!) as a template to mark your drilling positions, then move the case and drill the holes to mount the driver electronics.

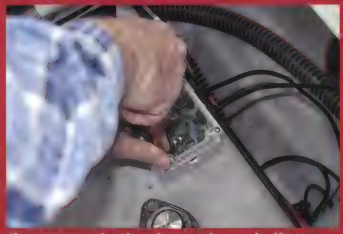


Photo 26: remember those four stainless steel self-tappers we told you not to discard? They're perfect for securing the case to its mounting position. A power screwdriver is a good idea here: we didn't have the right bit and screwing into the fibreglass was really tough going.

Photo 27: after mounting, connect to an appropriate battery (one that receives shore power or solar panel charging). Dress the leads so that they can't move around or vibrate (remember that there are severe stresses and forces at work in a boat, especially at speed). Use small cable ties to lace the cables to existing wiring.

Altium Designer is software for designing PC boards, circuit diagrams, Field Programmable Gate Array (FPGA) projects and embedded software. It can work with the NanoBoard 3000 hardware platform and its supplied software libraries let you quickly develop, test and debug a device without the need for any hardware design or manufacturing.

ARGUABLY THE premier design package in Australia, Altium Designer has so many features that it's impossible to cover them all in this review. Basically, it is a comprehensive electronics design package encompassing a PC board layout and circuit diagram editor, a Computer Aided Manufacture (CAM) manager, and an FPGA and embedded software Integrated Development Environment (IDE). Also included are simulation tools, version control, test instruments, software libraries and more.

This review refers to the features of the Summer 09 edition. We will cover the most important aspects of the software but will necessarily leave out others due to space constraints. If you require further information on these, take a look at Altium's online resources at **www.altium.com**

Migrating from other software

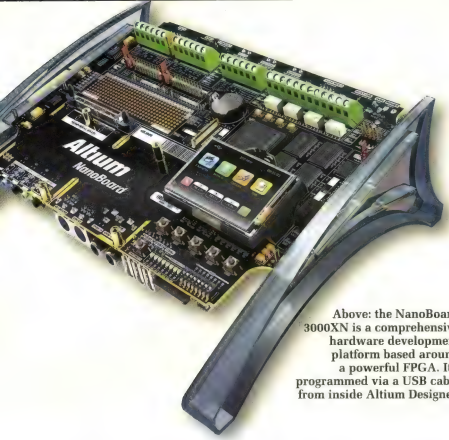
Many readers will be familiar with the existing Electronic Computer Aided Design (ECAD) packages such as Autotrax, Easytrax, Protel 2.8, Protel 99SE, EAGLE and KiCad. Other packages include Allegro and OrCAD from Cadence and PADS from Mentor Graphics.

Altium Designer is an all-in-one package which can do what they can and more. Its import wizards allow existing Autotrax, Protel, Allegro, OrCAD and PADS files to be used.

As Altium was formerly known as Protel, it's not surprising that Altium Designer retains some of the elements of Protel 99SE while adding new features and improving on old ones. If you've used Protel 99SE, migrating to Altium Designer will be relatively straightforward.

3D PC board editing

One of the great features of Altium



Above: the NanoBoard 3000XN is a comprehensive hardware development platform based around a powerful FPGA. It's programmed via a USB cable from inside Altium Designer.

Designer is its 3D visualisation package. This allows you to see what a PC board will look like in three dimensions while editing it without having to build it. The 3D rendering is fast enough to allow interactive use and you can even see the layers inside the PC board.

The 3D capabilities of Altium Designer are best explored with a SpaceNavigator™, a joystick-like device from a company called 3DConnexion (**www.3dconnexion.com**). It enables you to change the viewing position and zoom distance in an intuitive way. Altium Designer supports such devices out of the box but you can also use a mouse if necessary.

While Protel 99SE could produce a 3D view of a PC board, Altium Designer has a much better engine that allows some basic board editing in 3D mode. For example, components can be moved or deleted and properties can be changed.

The 3D view can be used to check that the PC board fits inside its enclosure, for example. This is done by superimposing a transparent 3D model of the enclosure on the board. It is also useful for checking for electrical errors in the layout of the PC board and for checking that parts don't physically interfere with each other. Copper tracks, vias and pads are rendered realistically, as well as any silk screen layers. This makes it easy to spot common errors, such as overlaying the silk screen on a pad or via.

While some of the components in the supplied libraries already have 3D bodies, you can also easily create a default component body by selecting which outlines to extrude. This will be sufficient in most cases but you can also add realism by using texture mapping, where an image can be attached to a component's surface.

However, texture maps cannot be wrapped around a cylinder, eg, for an electrolytic capacitor. Components without a 3D representation are simply shown as pads and silkscreen outlines.

Interactive routing

Arguably the most important part of a PC board layout tool is the track routing support and in this respect Altium Designer is exceptional. Its interactive routing modes include "Push and Hug" routing, "Walkaround" (track hugging) and "Track Slicing".

"Push and Hug" mode allows you to literally "push" a number of tracks to make room for new ones, without having to delete and re-route them. By contrast, "Walkaround" allows you to easily route a track so that it's adjacent to existing tracks, to most efficiently use the available board area, especially when routing busses.

Finally, "Track Slicing" allows you to break tracks along a line defined by the mouse. All these features are great aids in the sometimes painstaking work of routing PC boards.

Push and Hug is also handy when it comes to moving tracks. If there are several parallel tracks and you try to move the one at the edge inwards, they are all automatically moved so that they remain parallel with the appropriate clearance. Doing this in other ECAD packages can require a lot of manual editing.

There are other time-saving features. Tracks and pads are automatically labelled with the net name or pin designator if they are large enough. When the mouse is moved over a track, its entire net is highlighted, giving a clear indication of what it is connected to (a "net" refers to all the points in a circuit that are electrically joined).

One problem that many ECAD packages have is that tracks can become fragmented as they are edited. You can often end up with a track composed of separate smaller segments, which is undesirable.

Altium Designer takes a good approach – a background process is always running that automatically detects co-linear track fragments belonging to the same net and converts them to a single segment.

There are some rare cases where this process does not correctly merge segments, eg, if two segments are not perfectly aligned, so that they do not share a vertex. This can happen when changing the measuring unit for the grid from Imperial to metric or vice versa, where rounding off errors can be introduced.

Differential pair routing

For both radio frequency (RF) and high-speed digital signalling, good layout techniques are critical. A "differential pair" is a pair of tracks on a PC board which carry signals which are opposite in polarity. The same technique is used in twisted-pair cables as it reduces crosstalk and electromagnetic interference (EMI).

Proper differential routing is especially important in high-speed signalling applications such as Hi-Speed USB (Universal Serial Bus) 2.0. The USB D+ and D- lines are a differential pair, a requirement for achieving the maximum transfer rate of 480Mbps.

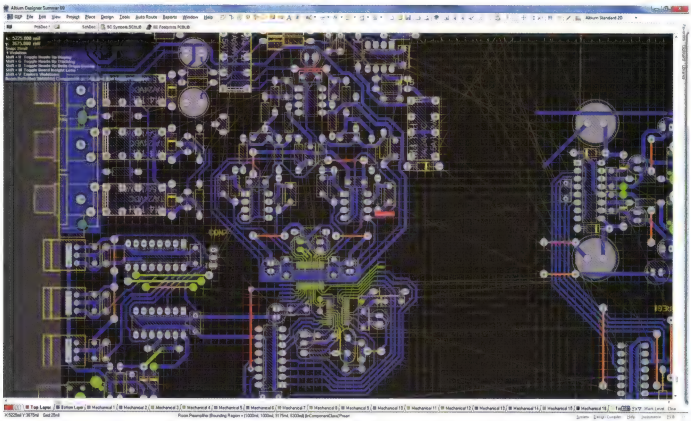


Fig.1: a 2D representation of a PC board in the layout editor. The blue tracks are on the bottom layer and the red tracks are on the top layer (representing wire links). You can also see the rats' nest connections corresponding to the nets in the circuit diagram. Note that, in practice, the colours are much more vivid on-screen than shown here.

This type of routing is becoming increasingly common with the growing use of faster serial busses like eSATA and USB 3.0.

Altium Designer allows you to tune the length and impedance of tracks as you route them. This is useful for impedance matching (which reduces signal reflections and therefore waveform distortion) and laying microstrips (a form of waveguide made from PC board tracks). These are especially important for wireless devices which can operate at 2.4GHz or more.

Multi-channel design

When designing a PC board, sometimes identical sub-circuits need to be laid out. For example, in a stereo audio design, the two channels may require duplicate circuits. A common solution is to lay out one channel and then duplicate it. However, this technique is less than ideal because when changes have to be made they must be made to all the copies.

Altium Designer takes a better approach to this with its "multi channel" design feature. You only maintain a single copy of the sub-circuit, which is then linked to multiple parts of the PC board or circuit diagram. When you change the master copy, all the other copies change too.

Layer stack

A PC board often consists of multiple layers although two layers is the most common (ie, a double-sided PC board). Different layers are shown in different colours, with blue often used to represent the "bottom" layer and red the "top" layer.

In order to connect a bottom layer track to a top layer track, a "via" is used. This is usually a small pad on each side of the board, with a copper-plated through hole connecting the two layers.

Vias are used for boards with more than two layers as well but in this case, they do not necessarily connect all the layers of the board. Some may not be visible on the surface of the PC board which is formed from a "sandwich" of substrates. The top and bottom layers are called "external" layers, while the rest are called "internal" layers.

While the 2D representation of the PC board can show the internal layers by using additional colours, as the layer count increases it becomes more difficult to see which layers a via is connected to, especially if it is a "blind" or "buried" via. A via which passes through one external layer but not the other is called a "blind via", while a via which is only between internal layers (and thus not externally visible) is called a "buried via".

Keeping track of which vias (or multi-layer pads) connect to which tracks is made easier by using the "Layer Stack" feature. This shows a cross section of the PC board around the selected via and shows which layers it connects to (see Fig.5).

Pin swapping

The PC board layout tool also allows you to perform "pin swapping". This is especially useful for designs using high pin count FPGAs or microcontrollers. It allows you to swap the nets (ie, all the connection points) associated with two pins.

If an IC's pins can be re-mapped, it's possible to greatly simplify the layout of the PC board by carefully selecting which pins connect where. This minimises track crossings (resulting in a much simpler layout), keeps tracks short and makes differential routing

Fig.2: a 3D view of the same PC board as in Fig.1. Realism has been added by defining leads for most of the components and texture maps for the relays and capacitors. The orange cone is the 3D cursor.

easier. Quite a few pins may need to have their functions swapped before the ideal layout is achieved, so automating this process is very helpful.

Linking to online databases

An important part of hardware design is selecting and sourcing components and the trend is to do this online. Altium Designer allows you to access suppliers' databases directly and large suppliers such as Farnell, Newark and Digikey currently offer access to their inventory via this software.

Not only can you search their online databases and access technical information about the component (including the data sheet) from within Altium Designer but you can also check stock levels and place an order. More importantly, with some of the newer components, you have access to component footprint information and STEP models (Standard for the Exchange of Product model data).

This allows you to insert the component directly into your design from the vendor without having to go though the time-consuming (and error-prone) process of manually creating component symbols and footprints.

STEP is a standard way of describing the mechanical specifications of a component. It can be used to give assembly details too, including any dependency relationships between components. For example, a component may need to be installed before another one, meaning the order of assembly may be crucial.

Altium Designer can also use these STEP models to render a 3D model of the component (for 3D visualisation of the PC board) and to improve its "Design Rule Checking".

Design Rule Checking

Design Rule Checking (DRC) is a way of verifying a PC board against a list of rules or "constraints". For example, you can check whether tracks or pads are too close together, or whether tracks that shouldn't be joined do in fact join. You can also check whether pins on a component have been left unconnected or if one component's body interferes with another.

Altium Designer's DRC is comprehensive and easy to customise. You can even check the integrity of a signal using its circuit simulator and any violations of the rules are summarised in a report file. Clicking on an error in the report takes you to the relevant place on the PC board, which is highlighted.

This list is also made available in a floating window, so that the violations can easily be checked in turn.

In addition, Altium Designer supports "Live DRC", with the board being checked against the design rules as you work on it. This is very handy as, for example, you can determine how wide a track can be to fit between components without violating clearance constraints and so on. Components which violate constraints are highlighted with a special pattern and annotated, thereby streamlining the design process.

Linking circuits & PC boards

Usually, a circuit diagram is drawn before PC board layout begins. To draw a circuit, Altium Designer's Graphical User Interface (GUI) allows components to be placed on a "sheet", labelled and connected via wires to form the nets.

Each component has both a symbol and one or more footprints associated with it. The symbol is used in the circuit diagram while one of the footprints is selected to go on the PC board.

Basically, the symbol represents the component's electrical proper-

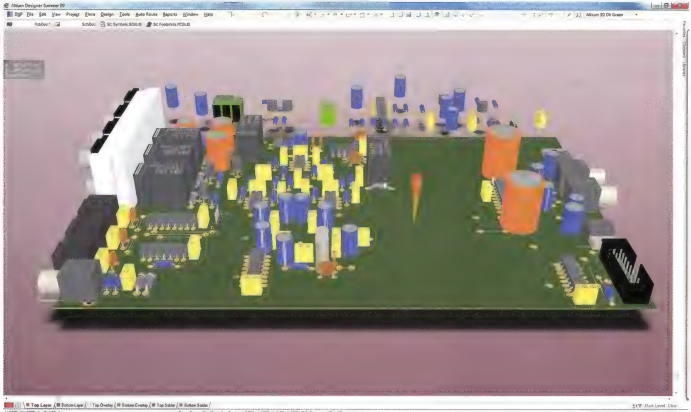


Fig.3: another 3D view, this time from the side. Unplaced components are visible in the background along with their rats' nest connections. The height of components is more obvious in this view.

ties while the footprint also contains mechanical information, such as the physical size of the component and its pad locations.

For a transistor, the symbol would be the typical transistor diagram showing the base, emitter and collector. The footprint, on the other hand, would typically consist of three pads and a silk screen outline of the body. It might also include additional information to render a more detailed 3D body, as shown in our screen grabs.

Once the circuit diagram is complete and has been successfully "compiled" (which involves creating a complete global netlist), you can "synchronise" the schematic to the PC board. This results in the appropriate footprints being placed adjacent to the board so that they can be moved onto it. You can see some of these unplaced components in Fig.3.

It is then possible to use either an automatic placement algorithm (which obeys the design rules) or manually place the components yourself. Lines are drawn between pads which need to be connected (the so-called "rats' nest") which can help determine the best location and orientation for each component.

If the circuit is later changed, those changes can be re-synchronised to the PC board and vice versa.

Circuit simulation

Altium Designer has integrated support for simulation environments, including ModelSim and various flavours of SPICE (Simulation Program with Integrated Circuit Emphasis). These numerical simulations, together with Altium Designer's virtual instruments and its support for test points, allow a design to be partly tested before it is built.

Manufacturing outputs

When the PC board is ready for manufacture, you can use the Computer Aided Manufacture (CAM) manager to export Gerber plot files, NC drill files and data in newer formats like ODB++ (a proprietary format that is increasing in popularity). These can then be sent to a PC board manufacturer.

The CAM manager is quite powerful. You can import Gerber files, "panelise" your design (ie, put multiple boards into one file) and create SMT (Surface Mount Technology) solder stencils for reflowing. You can also generate product assembly information, including files to control pick and place machines for assembly.

Altium Designer also makes it easy to generate a BOM (Bill Of Materials) for parts ordering. It can also produce schematic and PC board hard copies, manufacturing data, mechanical drawings and so on. You simply select what kind of data to produce and Altium Designer will generate the files with a single click of the mouse.

NanoBoard 3000

The NanoBoard 3000 is a hardware development platform that's integrated with Altium Designer. It is ideal for rapid prototyping but can also be used for production, especially where small runs are involved.

This can be economical as the extra cost of the hardware can be offset by greatly reduced development time. In addition, Altium can supply modular and stackable plastic enclosures for the NanoBoard.

The NanoBoard 3000 contains an impressive amount of hardware, the core being a powerful FPGA. In fact, there are actually two FPGAs on the NanoBoard 3000, with one used to program the other and to control the peripheral functions.

As well as generous amounts of DRAM, SRAM and FLASH memory, the NanoBoard 3000 also has the following peripherals:
(1) a battery-backed Real Time Clock (RTC);
(2) a 3-port USB host controller;
(3) a USB 2.0 Hi-Speed device port;
(4) an ethernet controller and port;
(5) an SVGA port;
(6) MIDI input and output ports;
(7) RS485 and RS232 serial ports;
(8) an analog audio output, input and headphone connector;
(9) PS/2 ports for keyboard and mouse;
(10) S/PDIF digital audio input and output ports;
(11) a TFT QVGA (320 x 240) LCD touchscreen;
(12) stereo speakers;
(13) four relay outputs;
(14) two memory card sockets;
(15) analog-to-digital converters (ADCs) and digital-to-analog converters (DACs);
(16) RGB LEDs and an IR receiver.

In addition, there's a prototyping area on the board and external connections can easily be made using the terminal blocks. It's also possible to connect "daughter boards" for WiFi, GSM modem or bluetooth support and a USB 2.0 WiFi adapter can also be used.

PC board layouts and circuit diagrams for the NanoBoard and the daughter boards are provided with Altium Designer, so you can even design your own daughter boards. The board is supplied with a USB cable, a switchmode plugpack, a generic infrared remote control and a stylus for use with the touchscreen.

Note that there are different NanoBoards available, depending on which FPGA you prefer. The model we tested was the NanoBoard 3000-XN, equipped with a 676-pin Xilinx Spartan 3 FPGA in a small Ball Grid Array (BGA) package.

The Spartan 3 has an equivalent gate count of 1.4 million and this is enough to implement a 32-bit CPU (known as a "soft core") with room left over for peripherals. Once the soft core is loaded onto the FPGA, you can write firmware for it just like you would a regular microprocessor, with the added benefit of customisable peripherals.

FPGA configuration

The NanoBoard 3000 plugs into your PC using the supplied USB cable and is configured via Altium Designer. This includes configuring the FPGA and loading software into it for any soft cores being used.

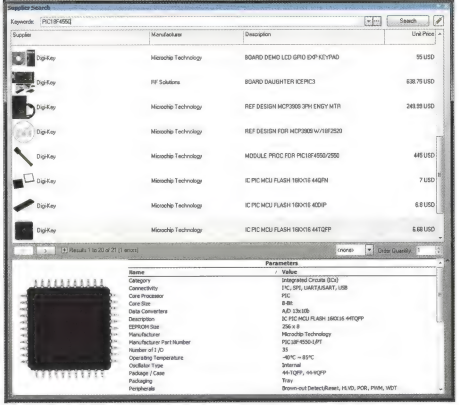


Fig.4: a screen grab of the online database access window. In this case, we are accessing the online database of Digikey, looking at a Microchip microcontroller.

Altium Designer has a GUI for FPGA design. You can draw a diagram consisting of logic blocks, inverters, gates, flipflops, shift registers and so on, all the way up to soft cores and peripherals. The "synthesis software" then configures the FPGA to implement your design. It's a great teaching and development tool, as very little knowledge of the low-level details is necessary to design a working project. For more complex designs, Verilog or VHDL can be used to describe the desired hardware. Each FPGA vendor provides free synthesis tools for their range of FPGAs. This must be installed so that Altium Designer can work with it.

The FPGA component libraries included with Altium Designer have Wishbone-compliant interfaces. This means that they are compatible with many of the OpenCores designs. Wishbone is an open source bus for connecting hardware blocks. OpenCores is a project that aims to provide open source hardware components in the form of verified HDL (Hardware Description Language) code.

For more information on this, go to **http://opencores.org/** Adhering to this standard allows freely available code to be imported into your next design, thus saving development time.

Embedded software IDE

Altium Designer supports embedded software development by including C and C++ compilers, as well as various assemblers.

If you are using one of the royalty-free IP soft cores, the software libraries include a lot of the low-level driver software for the hardware interfaces. This includes a TCP/IP stack, USB pro-

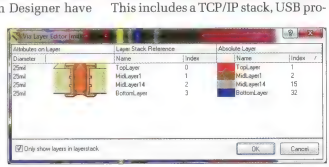


Fig.5: the "Layer Stack" shows a cross-section of a via or pad. It can be used to see what layers the via connects to, a feature that's especially important for PC boards with more than two layers.

What is A Field Programmable Gate Array?

An FPGA (Field Programmable Gate Array) is a digital IC that is software configured using a Hardware Description Language (HDL). You can think of it as a custom digital logic IC that can be configured to suit your application.

While both FPGAs and microprocessors can be reconfigured to suit the task at hand (in the latter case, via software), the ability to change an FPGA's hardware configuration means that it can usually deliver much greater performance for the same clock speed and power consumption. This is possible because an FPGA consists of many "logic blocks" which are connected via multiplexed lines (or "multiplexes").

There are many general-purpose logic blocks for performing arbitrary operations, as well as specialised units to perform common tasks such as data storage, multiplication, shifting, etc. The multiplexes are configured by memory (usually SRAM, EEPROM or Flash) and this determines how the logic blocks are interconnected, so by writing to this memory, the circuitry is reconfigured. It is a bit like a giant high-speed breadboard with programmable wire links.

Virtually any digital circuit can be implemented on an FPGA, as long as it has enough logic blocks. The "equivalent gate count" statistic is an estimate of how the FPGA compares to an Application-Specific Integrated Circuit (ASIC, ie, custom IC). If an FPGA is quoted as having one million equivalent gates, then it can take on the function of a typical ASIC with one million gates or less.

This statistic is especially useful for comparing FPGAs across different manufacturers since the internal structure can be different and therefore comparing the number of logic blocks is not valid.

The best FPGA performance is achieved by making full use of its specialised logic blocks while keeping the interconnections as short as possible. Fortunately, you don't have to worry about that, as the synthesis software provided by the FPGA manufacturer works it out for you automatically.

A hardware synthesis tool is a program which takes a circuit description and determines the best way to implement it using the available hardware building blocks. Typically, the input to a synthesis tool is a Hardware Description Language (HDL) such as Verilog or VHDL. However, with Altium Designer, you can draw an equivalent circuit diagram and the software will generate the HDL for you.

Note that hardware synthesis tools are also available for ASIC design so hardware which is prototyped in an FPGA can later be built into a custom IC which will be smaller and faster. While custom ICs are cheaper in large quantities, the set-up costs are huge, so FPGAs are often used for small production runs.

tocol handlers, MIDI and audio codecs, image processing libraries and much more. In short, the software support is truly comprehensive.

Version control

In any project large enough to require multiple designers, version control is critical. Version control systems allow many people to work on a large set of files without "stepping on each others' toes". It also helps track down bugs by storing a history of changes for each file and assists with upgrades and testing by keeping track of multiple file and project revisions.

Altium Designer integrates with open source version control systems like CVS and Subversion. These are also useful for creating automatic back-ups, while the ability to revert to an earlier, stable version lets you add features with minimal risk. Comparison engines allow you to track and merge changes between different file versions.

C-to-hardware compilation

A unique feature of Altium Designer is its ability to automatically build hardware acceleration support for C functions. The compiler can automatically implement hardware in the soft core to accelerate performance-critical functions within the software. This is possible because both the hardware and software can be reconfigured to suit each other.

This technique can yield substantial gains in performance, especially for computationally-intensive routines. While there are some limitations as to what kind of functions can be exported to hardware, it is a powerful feature.

Online resources

Altium Designer gives you access to a wealth of online resources. It includes an integrated web browser which you can use to access the Altium Wiki, the "Resource Center" (with videos and tutorials) and an online community with forums. There is also a Support CENTER, accessible with a valid licence, for better technical support.

Tutorials are freely available online and some training will be needed to use the software effectively. Training sessions are hosted by Altium on a regular basis.

Conclusion

Altium Designer is not simply a suite of tools and substantial effort has been put into integrating all the components. There are powerful cross-probing features, where you can select an item on the circuit diagram and have it selected on the PC board as well. Overall, it is a comprehensive and well-presented package.

There are various licencing options for Altium Designer. The standard perpetual licence costs $A6240 + GST but you would also usually purchase a 12-month software assurance for an extra $A1995 (exc. GST), giving access to the biannual updates. This software assurance can (optionally) be renewed annually.

For students, Altium offers complete versions of Altium Designer on 12-month licenses for $A115 + GST.

The NanoBoard 3000XN costs $A495 (exc. GST) and includes a "soft design licence" for 12 months, allowing you to use the FPGA tools in Altium Designer for development. This licence expires after a year unless you renew it for another year for $A295 (exc. GST).

While Altium Designer is not cheap, it offers good value for the amount of software provided. It is a complete solution for almost all general electronic design and also includes access to online resources and support.

Although the software has been optimised for performance, you will need a reasonably up-to-date system to use it effectively. Altium's website lists the minimum requirements.

Contact details

For further information on Altium Designer or the NanoBoard 3000, contact Altium. Their website at **www.altium.com** contains a lot of information about their products, including information on new features. SC

PRODUCT SHOWCASE

New extremely fast Universal Programmer – Elnec BeeProg2

The Elnec BeeProg2 48-pin universal programmer, currently supports more than 52,000 devices. Since programming times are faster than ever before, this new product will appeal not only to hardware developers but also to small and medium sized manufacturers.

It reliably programs a wide range of programmable chips in the ZIF socket (and more than 800 models of socket converters are available) as well as through the ISP connector. Elnec's programmer software allows up to eight BeeProg2 programmers or its predecessors (BeeProg+ or BeeProg) to be connected and operated from one PC making for a very flexible production solution. Furthermore, as a whole it works as a concurrent multiprogramming system. As a result, each programmer can work independently, programming different types of chip when necessary. This solution saves user's time and also staff and hardware.

The BeeProg2 also tests TTL/CMOS logic ICs and memories, performs device insertion tests (wrong or backward position) and contact checks (poor contact pin-to-socket) before it programs each device. These capabilities, supported by overcurrent protection and signature-byte check, minimize the possibility of chip damage due to operator error.

The programming speed increase for serial and parallel NAND and NOR Flash memories means, in absolute numbers, that the BeeProg2 can program and verify a 64 Mbit NOR Flash in less than 13s and program and verify 1 Gbit NAND Flash in less than 123s. The BeeProg2's programming times are comparable to competing programmers claiming to offer "ultra-fast programming speed" and costing up to 50% more.

Australian price is $1400.00 + GST ($1540 inc).

Contact:
GRANTRONICS Pty Ltd
PO Box 275, Wentworthville NSW 2145
Tel: (02) 9896 7159
Website: www.grantronics.com.au

USB 3.0 Portable Hard Drives from Verbatim

Verbatim's new generation USB 3.0 Store'n'Go Portable Hard Drives deliver bus speeds of up to 4.8Gbit/sec – a ten-fold increase in performance compared to existing USB 2.0 connections – making them ideal for both home and office-based users who want to transfer large files with the newest and quickest technology available.

They are available in 500GB and 1TB capacities. At 127 x 82 x 20mm in size and weighing approximately 165g (for the 500GB version), the superfast USB 3.0 Portable Store'n'Go Hard Disk Drive sits comfortably in the palm of the hand, or fits neatly in any lady's handbag or man's jacket, making it easy to carry around. The single-cable solution provides a combined data and power connection eliminating the need for a separate power supply. The drive comes with a 24 month guarantee.

Included on the Store'n'Go USB 3.0 Portable Hard Drives are two software packages: Nero BackItUp and Burn Essentials and The GREEN BUTTON which reduces energy consumption and extends the drive's life expectancy.

Contact:
Verbatim Australia
6 Weir St, Glen Iris, Vic 3146
Tel: (03) 9823 0999 **Fax:** (03) 9824 7011
Website: www.verbatim.com.au

WES expands SB Acoustics range, lowers prices

WES Components have recently added significantly to their range of popular SB Acoustics premium speakers and at the same time, offer even better pricing.

Aimed at the higher end of the market, the SB range includes ring and textile dome tweeters, 4, 5 and 6-inch midrange/bass drivers and 8, 10, 12 and 15-inch bass drivers, subwoofers and the latest models, the NRX series which use an in-house-developed cone material called Norex.

SB Acoustics was formed to bring an alternative to the high-end transducer market. It marries the design talents of Danesian Audio (Denmark), a company responsible for many well-known and revolutionary designs, with manufacturing partner Sinar Baja Electric (Indonesia), a vertically integrated company with more than 27 years of transducer manufacturing experience. More information on the SB Acoustics speaker range from WES can be found at the SB Acoustics website, www.sb-acoustics.com. SC

Contact:
Wagner Electronic Services
138 Liverpool Rd, Ashfield NSW 2131
Tel: (02) 9798 9233 **Fax:** (02) 9798 0017
Website: www.wagner.net.au

Vintage Radio

By RODNEY CHAMPNESS, VK3UG

Traeger's first pedal radio & other replicas

This is the view inside John Sheard's replica pedal radio. The degree of authenticity is astonishing.

I never cease to be amazed at the vintage radio collections that some enthusiasts have. One such enthusiast is John Sheard of Mt Gambier. He not only has an impressive collection of vintage gear but has built some impressively realistic replicas as well.

SOMETIMES, while searching for vintage radios, you get a real surprise. One such instance happened to me a couple of years ago when I visited John Sheard in Mount Gambier, to see his collection of vintage sets.

When I got there, I was immediately ushered down the hall to the room where his collection was housed. And did I get a shock because there in the corner was what appeared to be one of the original six pedal radios built by Alf Traeger in 1929, for use in the Aerial Medical Service (the predecessor to the Royal Flying Doctor Service).

In researching my book, "Outback Radio from Flynn to Satellites", I had previously concluded that none of these original sets had survived and yet here was one fully restored. I just couldn't believe it. Then John let me into the secret; this set is a replica of the original and matches it closely in nearly every detail.

In fact, he had used the information in my book, including the photos and the circuit, to build this great working replica.

Back in 1928, Alf Traeger, with help from his mentor Harry Kauper, built what proved to be the first transceiver capable of being used by non-technical people in remote areas without mains power. This meant that the transceiver had to be frugal in terms of power usage and in order to generate enough energy to operate the transmitter, a high-voltage generator was used. The final testing of the first practical pedal radio took place in November 1928.

The pedal radio transmitter used a single B205 triode as a crystal oscillator-cum-output stage. The transmitter had an output power of 1-1.5W on Morse code at a frequency of 2230kHz. It was a Morse code-only transmitter as Traeger, Kauper and many others had told the Reverend John Flynn that voice transmissions were not practical at that time due to the high power consumption of such transmitters.

Indeed, "low-power" battery valves suitable for use in voice transmitters did not become available until the mid 1930s.

The receiver in the pedal radio was a 2-valve regenerative TRF (tuned radio frequency) unit. It employed two A141 space-charge tetrode valves that required no more than 20V on their plates, although in this set only 9V was used. There was just one tuned circuit but two separate coils were used to gain the necessary coverage. One coil allowed the set to tune the broadcast band while the second coil is believed

The photo at left shows John Sheard posing with his replica pedal radio while at right is Alf Traeger with an original.

to have tuned from around 1.5-4MHz.

The original pedal radios were located in the hot and often humid areas around Cloncurry in Queensland. As a result, their dry batteries had a relatively short shelf-life. It was for this reason that 1.5V and 3V supplies were used for the valve filaments in the receiver and just 9V for the high-tension (HT) supply.

By contrast, it was necessary to use much higher voltages for the transmitter and dry batteries were unsatisfactory for this work. To solve this problem, Traeger developed a pedal generator that produced nominally 180V of HT and this proved adequate for the transmitter.

John's replica pedal radio

Although John would have liked to have built a completely accurate replica of the original Traeger pedal radio, many of the original components are unavailable today. The wave-change switch is a standard Oak wafer switch, not one of Traeger's home-made ones, and many of the other components are items as close as John could either obtain or make for the set.

None of the valves were obtainable so John initially put FETs inside old valve envelopes to take the place of the original A141 valves used by Traeger. He also used a B405 valve instead of a B205 in the transmitter. The main difference between the B405 and the B205 is the required filament voltage.

The A141 valves were eventually replaced with B443 valves and the FET mock-ups discarded. Although the B443 is not even a near-equivalent to the A141, John found that they worked like the A141 in this circuit. It really is the best compromise solution achievable, considering A141 valves are now rarer than hens' teeth.

John built the pedal generator with help from his son Trevor. It consists of a low-voltage generator that puts out about 6V and this is then stepped up to around 180V via a transistor inverter.

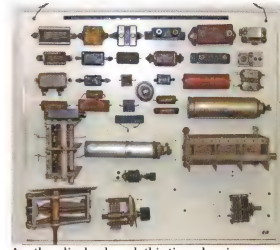
Because he holds an amateur radio licence (VK5JA), John installed a crystal in the transmitter so that it operates on the 3.5-3.7MHz amateur band. Both the transmitter and the receiver work well and John has had quite a few contacts with the set.

As I said earlier, this replica initially fooled me so John is to be congratulated on the detail he has achieved.

By the way, if readers would like to

This working replica of 1902 coherer detector receiver is similar to those used by Marconi in the early days of radio.

A feature of John's collection are some impressive display boards. This one shows a range of different valve types.



Another display board, this time showing a range of vintage-era fixed and variable capacitors.

A replica 1915-era crystal receiver. These were widely used until valves became in the early 1920s.

read more about the development of radio communications in the outback, my book "Outback Radio From Flynn To Satellites" is still available from me for $30 plus $5 postage.

Miniature 6-valve superhet

Another of John's challenges was to build a miniature 6-valve superhet receiver and the set he developed fits comfortably in the grasp of one hand. However, the chassis isn't particularly crowded and the set could have been made even smaller.

The valves are all sub-miniature mains-operated types that are not readily available in Australia. The oscillator mixer is an XR9, which is a twin triode, and this is followed by a 2-stage IF (intermediate frequency) amplifier tuned to 455kHz using two EF70 sharp cut-off pentodes. Solid-state diodes are used for the detector and AGC functions, while an ECC70 twin triode is used as an audio amplifier and phase splitter. This feeds another two ECC70 twin triodes wired in push-pull parallel as the audio output stage.

The IF transformers and the tuning gang are all types commonly used in transistor radios. These have helped to keep the size of the set down. The HT (high tension) for the receiver is only 90V, so these parts are not unduly stressed.

The only section of the receiver not inside the cabinet is the 36V AC plug-pack supply. I'm sure that John could have fitted the pack inside the cabinet but he chose to keep it external. The 36V AC is applied across the valve heaters (which are connected in series) and also goes to a voltage multiplier circuit which produces the 90V HT for the plates.

All in all, it's an interesting little receiver that sounds very pleasant in operation.

Display boards

Most vintage radio buffs know what each item in their collection is and can tell you something about it but not many label their prized possessions, even if they are on display. In fact, this also often happens in museums, particularly the smaller ones. It is disappointing to see items on display and not know what they really are or at best, have only limited information on them.

John labels the majority of his displays and it is easy to learn a little

about what particular items are.

For example, there are two displays of valves, one covering most of the valve era and the other only triode valves of the 1920s. John endeavoured to sell these displays some time ago but was not offered a reasonable price for them. Afterwards, he did a check on the individual going price for the valves in the displays and got quite a shock, as their value is greater than he initially thought.

Another of the displays is of older fixed and variable capacitors – types that many younger collectors are unfamiliar with.

We've had mobile phones now in one form or another since the 1950s. I visited the Ansett Museum in Hamilton and saw some of the early units. Mobile phones at that time were the province of the rich and only about 50 subscribers could be accommodated by any single PMG telephone exchange.

The system was largely a manual system whereby the mobile user would call the operator who would then connect them to the called party. When a caller from a fixed-line phone made a call to a mobile subscriber, the telephone operator would call the particular mobile via a tone encoder system.

The equipment used was large and sets such as the AWA MR10 VHF transceiver were used. It was usually mounted in the boot of the vehicle due to its size. There was no privacy with this system as anyone with a suitable FM VHF receiver could listen in to the phone calls. However, scanning receivers were uncommon at that time so conversations were reasonably private.

John's display doesn't go back that far but he has quite a selection of equipment on display, dating from the late 1980s through to the end of the CDMA era. Early 1980s mobile phones were considerably more bulky than those of the late 1980s but were nothing like the units from the 1950s.

A general view of just some of the gear in John's collection. He has an impressive range of vintage and replica equipment, including some military gear.

This working unit is a replica of Marconi's first diode valve receiver, as used on the steamship Titanic in 1912. Note the brass fittings used in this model.

Pyrox wire recorder

One of John's prized possessions is a Pyrox wire recorder, which was previously owned by "Border Watch", the local area newspaper.

Wire recorders were used before tape recorders came on the scene and John's unit was made during the 1940s. Wire gave way to tape as a recording medium during the early 1950s.

What makes this particular recorder special is what is on the spool of wire. It records the official opening of the broad-gauge railway line between Wolseley and Naracoorte in South Australia by the Governor Sir Willoughby Norrie on February 1st, 1950. Other notables on the recording are the Minister for Railways, Malcolm Macintosh and the Premier, Sir Thomas Playford.

So we have in this one piece of equipment not only an early audio recording device but also a priceless historical audio record.

The Titanic

Many of us are familiar with the maiden voyage of the "Titanic" and its tragic end.

"Titanic" was equipped with Marconi radio equipment and John has faithfully reproduced some of this equipment using plans from Dr Peter Jensen's book "In Marconi's Footsteps

This Australian Army C42 military transceiver has 25 valves packed into a compact unit but is easy to open up for servicing.

John's Pyrox wire recorder was previously owned by *Border Watch*, the local area newspaper. Wire recorders gave way to tape recorders in the early 1950s.

– Early Radio". A beautifully-made replica of the diode valve receiver used on the "Titanic" is the result of John's efforts.

In order to make this replica plus a number of other items from the same era, John had to source a sizeable quantity of brass. This was an expensive part of the project, as it wasn't readily available from local metal suppliers.

The coherer detector

One of the early detectors used in the pre-valve days was the "Coherer" detector (see Vintage Radio for April 2010). John's replica is of a 1902 model and is similar to those used by Marconi. They are certainly quite different to the small silicon diodes that we are accustomed to using today.

1920s crystal set

Another of John's replicas is a crystal set of the style commonly used until around 1920 when valves became more than a delicate novelty. Despite the fact that they were only crystal sets, these early receivers would have cost a fortune to construct. Many had adaptable tuned circuits and matching networks so that the maximum possible signal level could be extracted from the antennas then in use.

An early portable receiver

In the late 1920s, there were many hundreds of experimenters who built radio receivers to sell to people in their neighbourhoods. It was a time when commercially-available receivers were not common and those that were available were expensive.

In fact, John's own father, a real "wireless" enthusiast, built a small number of sets in the evenings after his day-time work as a draper was complete. One such 4-valve portable receiver was housed in a wooden cabinet and features a loop antenna which sits behind the front cover of the receiver. This is simply swung out when the receiver is to be used.

The set is a battery-operated TRF design using an Osram S625 screen-grid RF amplifier. This is followed by a 615 triode detector and a further two transformer-coupled triode audio stages.

The S625 is unusual in that it is double-ended, with three pins (the filament and grid pins) at one end and the screen and plate pins at the other end. The valve is mounted with one

This Ericsson 1-131MW wall-type telephone was made in 1907 and has been immaculately restored.

end through a hole in the side of a copper box which also houses the second tuned circuit. This effectively keeps its input and output pins separated and shielded.

This was quite an innovative design for its time and John says that the set is quite stable and the performance is excellent for a receiver of its vintage.

Communications in 1907

Another item that John has immaculately restored is a Swedish Ericsson 1-131MW wall-type telephone, made in 1907. This particular model was first introduced in 1890.

On a wall near the telephone is the telephone directory for the Mt Gambier exchange for October 1904. There were 47 telephone subscribers listed and there were two lines to Robe and Beachport, both towns further along the coast towards Adelaide. The hours of operation were 8.30am to 7.30pm Monday to Friday, 8.30am to 5.30pm Saturday and no service on Sundays. How things have changed since then.

Accessibility

John also has a number of other pieces of equipment, mostly of military or commercial origin. One such item is a C42 military transceiver. There are 25 valves in the unit plus the associated components, yet it is easy to open up and access for routine servicing. That's because the set is built onto two main chassis and these hinge, allowing easy access to all components that may need attention at some stage.

On the other hand, his AWA AR8 receiver is a nightmare to service. This receiver uses two RF front-ends to tune from 14kHz to 20MHz.

In order to service either of the front-end units, the front panel has to first be removed along with a dozen or so knobs. That done, the connections to the main chassis have to be desoldered, then the sub-chassis for either of the front ends is unbolted after which the particular front-end can then be removed.

But that's not the end of it – the next task is to gain access to most of the components. To do this, a long needle-nose set of pliers and a slim soldering iron are needed. It is not possible to power the front ends up to check their performance in this state, although it's possible that the military had a jig to get around this problem.

Photo Gallery: Healing Golden Voice Console

MADE during the 1940s, the Healing Golden Voice console model 577E, like all console radios, has acres of room around the chassis and speaker, so it's easy to service. It also gives much better performance than compact mantel radios, due in part due to its large, well-baffled loudspeaker. It is a 5-valve superhet and the valve line-up is 6J8G, 6U7G, 6B6G, 6V6GT and 5Y3G rectifier. Photograph by Kevin Poulter for the Historical Radio Society of Australia (HRSA). Phone (03) 9539 1117. **www.hrsa.net.au**

In short, the AR8 amply demonstrates how difficult some pieces of equipment are to service, while the C42 transceiver is the opposite (see photo). Similarly, the AWA 617T 7-band receiver takes nearly half an hour to disassemble for service while a small Precedent 4-valve mantel receiver in my collection takes less than a minute.

Military radio gear (25D13)

I could go on for some time but here is just a short list of some of the military equipment on display: AR8 and AR7 communications receivers, command transmitting and receiving equipment, an FS6 army transceiver (see May 2002 issue), a Bendix frequency meter and a 128 back-pack, 1W, 2-4.5MHz transceiver.

Many vintage radio buffs only collect domestic receivers even though our radio communications heritage covers a vast number of areas. On the other hand, a few collectors go well beyond domestic receivers and their collections can be extremely interesting. John is one of those people and I thank him for the opportunity to show readers his collection of vintage gear and replicas. SC

SILICON CHIP REFERENCE BOOKSHOP

STOP PRESS! **Better exchange rate means lower prices on many imported books. Hurry and Save while A$ is high – we pass lower prices on to you and YOU REAP THE BENEFIT!**

PIC IN PRACTICE by D W Smith.

2nd Edition - published 2006

Based on popular short courses on the PIC, for professionals, students and teachers. Can be used at a variety of levels. An ideal introduction to the world of microcontrollers. 255 pages in paperback. ~~$95.00~~

$60 NEW LOW PRICE!

PIC MICROCONTROLLERS: know it all Multiple authors

The best of subjects Newnes authors have written over the past few years, combined in a one-stop maxi reference. Covers introduction to PICs and their programming in Assembly, PICBASIC, MBASIC & C. More than 900 pages paperback.

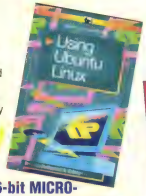
$90

PIC MICROCONTROLLER –YOUR PERSONAL INTRODUCTORY COURSE

By John Morton 3rd edition 2005.

A unique and practical guide to getting up and running with the PIC. It assumes no knowledge of microcontrollers – ideal introduction for students, teachers, technicians and electronics enthusiasts. Revised 3rd edition focuses entirely on re-programmable flash PICs such as 16F54, 16F84 12F508 and 12F675. 226 pages in paperback.

$60



USING UBUNTU LINUX

by J Rolfe & A Edney – published 2007

Ubuntu Linux is a free and easy-to-use operating system, a viable alternative to Windows and Mac OS. Introduces Ubuntu, tells how to set it up, covers the various Open Office applications and gives troubleshooting hints and tips. Highly recommended.

222 pages in paperback

$27

NEW LOW PRICE!

PROGRAMMING 16-bit MICROCONTROLLERS IN C By Luci di Jasio (2007)

Subtitled Learning to Fly the PIC 24, a Microchip insider tells all on the newest, most powerful PICs ever! Condenses typical introductory "fluff" focusing instead on examples and exercises that show how to solve common, real-world design problems quickly. Includes handy checklists.

FREE CD-ROM includes source code in C, the Microchip C30 compiler, and MPLAB SIM.

400 pages paperback. ~~$99.00~~

CD-ROM included!

$83

TV ACROSS AUSTRALIA

Edited by Kaz Bielecki – 4th Edition 2007

Essential information for anyone travelling Australia, or just wanting to know the channels, polarity and location of all television transmitters and translators from coast to coast.

Plus coverage maps, tv transmitter data . . . everything you need to know in the one place for the first time!

$49.95

PRACTICAL GUIDE TO SATELLITE TV

By Garry Cratt – Latest (7th) Edition 2008

Written in Australia, for Australian conditions by one of Australia's foremost satellite TV experts. If there is anything you wanted to know about setting up a satellite TV system, (including what you can't do!) it's sure to be covered in this 176-page paperback book.

$49

NEWNES GUIDE TO TELEVISION & VIDEO TECHNOLOGY

By KF Ibrahim 4th Edition (Published 2007)

It's back! Now in a new edition provides a full and comprehensive coverage of video and television technology including HDTV and DVD. Starts with fundamentals so is ideal for students but covers in-depth technologies such as blu-ray, DLP, Digital TV, etc so is also perfect for engineers. 600+ pages in paperback. ~~$79.00~~

$58

NEW LOW PRICE!

RF CIRCUIT DESIGN

by Chris Bowick, Second Edition, 2008.

A new edition of the classic RF circuit design book. RF circuit design is now more important that ever in the wireless world in which we live. In most of the wireless devices that we use there is an RF component – this book tells how to design and integrate in a very practical fashion. 244 pages in paperback. ~~$75.00~~

$74

NEW LOW PRICE!

OP AMPS FOR EVERYONE

NEW 3RD EDITION! NEW LOWER PRICE!

By Carter & Mancini. Substantially updated coverage for low-speed and high-speed applications, and provides step-by-step walk-throughs for design and selection of op amps. Huge 648 pages!

~~$129.00~~

$119

HANDS-ON ZIGBEE

By Fred Eady, Published 2007

We asked our Zigbee guru, Telelink's Jack Chomley, to comment on this book and he said a lot of it is pretty in-depth but if you want to learn all about Zigbee you'd go a long way to find a better reference than this one. 336 pages in paperback. ~~$99.00~~

LIMITED STOCK – WHILE THEY LAST!

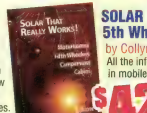
NEW LOW PRICE!

$75

SOLAR SUCCESS – Getting it right every time by Collyn Rivers. 1st edition

The complete guide to home and property systems. Covers the ramifications of lighting, fridges and freezers, air conditioning, washing machines and driers and much more on solar systems; also covers solar basics and how to conduct an energy audit. As reviewed in SILICON CHIP November 2008. 112 pages.

$47.50



SOLAR THAT REALLY WORKS – Motorhomes, 5th Wheelers, Campervans, Cabins

by Collyn Rivers. 2nd edition

All the information you need for successful solar installation in mobiles.An expert on getting the most out of solar systems, Collyn Rivers dispels many of the myths and helps you get it right when there is no mains power available.

$42.50

WANT TO SAVE 10%? SILICON CHIP (PRINT EDITION) SUBSCRIBERS* AUTOMATICALLY QUALIFY FOR A 10% DISCOUNT ON ALL BOOK PURCHASES!

10% OFF!

(*Does not apply to website orders)

See the handy order form on P43 of this issue!

SILICON CHIP'S PERFORMANCE ELECTRONICS FOR CARS Published 2004

If you ever wanted top performance from your car, this is the book you need. 160 pages of technical background to give you a thorough understanding then 16 specialised projects to build to make your car really perform, including engine modifiers and controllers, instruments and switches.

$19.80

AC MACHINES

By Jim Lowe Published 2006

Applicable to Australian trades-level courses including NE10 AC Machines, NE12 Synchronous Machines and the AC part of NE30 Electric Motor Control and Protection. Covering polyphase induction motors, single-phase motors, synchronous machines and polyphase motor starting. 160 pages in paperback.

$66

DVD PLAYERS AND DRIVES

By K.F. Ibrahim. Published 2003.

A guide to DVD technology and applications, with particular focus on design issues and pitfalls, maintenance and repair. Ideal for engineers, technicians, students of consumer electronics and sales and installation staff. 319 pages in paperback. ~~$95.00~~

As reviewed in SILICON CHIP February 2004.

$85

NEW LOW PRICE!

PRACTICAL VARIABLE SPEED DRIVES AND POWER ELECTRONICS

by Malcolm Barnes. 1st Ed, Feb 2003.

An essential reference for engineers and anyone who wishes to design or use variable speed drives for induction motors. As reviewed in SILICON CHIP September 2003. 288 pages. ~~$196.00~~

NEW LOW PRICE!

$88

ELECTRIC MOTORS AND DRIVES

By Austin Hughes - Third edition 2006

Brand new edition of this amazingly popular book. Intended for non-specialist users of electric motors and drives, filling the gap between academic texts and general "handbooks". Explores all of the widely-used modern types of motor and drive including conventional & brushless DC, induction motors, steppers, servos, synchronous and reluctance. 384 pages, soft cover.

$60

SWITCHING POWER SUPPLIES A to Z

by Sanjaya Maniktala. Published 2006.

Theoretical and practical aspects of controlling and measuring electromagnetic interference in switching power supplies. Includes flow-charts for building DC-DC converters and their magnetic components under typical wide-input supply conditions. 503 pages in hard cover. ~~$116.00~~

NEW LOW PRICE!

$108

CD-ROM included.

SILICON CHIP'S ELECTRONIC PROJECTS FOR CARS VOL 2 Pub. 2003 - SAVE $18.00!!!

Even though it's seven years old, there's a wealth of information in this 128-page softcover book for anyone who wants to build car projects: everything from electronic ignition systems to digital tachos, headlight reminders and car alarms, a subwoofer and even an an alcohol breath tester.

BE QUICK! LAST FEW shop soiled copies left – *while they last* – ONLY $2.95 ea! ~~$12.95~~

$12.95

See Review March 2010

NEW LOW PRICE!

$114

AUDIO POWER AMPLIFIER DESIGN HANDBOOK

by Douglas Self **NEW 5th Edition 2009**

The latest edition of "the Bible" on audio power amplifiers. Many revisions and updates to the previous edition and now has an extra three chapters covering Class XD, Power Amp Input Systems and Input Processing and Auxiliarly Subsystems. Not cheap and not a book for the beginner but if you want the best in Audio Power Amps, you want this one! – 463 pages in paperback. ~~$139.00~~

NEW LOW PRICE!

$82

SELF ON AUDIO

by Douglas Self 2nd Edition 2006

A collection of 35 classic magazine articles offering a dependable methodology for designing audio power amplifiers in a way that improves performance at every point without significantly increasing cost. Includes compressors/limiters, hybrid bipolar/FET amps, electronic switching and more. 474 pages in paperback. ~~$99.00~~

NEW LOW PRICE!

$73

PRACTICAL RF HANDBOOK

by Ian Hickman. 4th edition 2006

The latest guide to RF design for engineers, technicians, students and enthusiasts. Covers key topics in RF: analog design principles, transmission lines, couplers, transformers, amplifiers, oscillators, modulation, transmitters and receivers, propagation & antennas. 279 pages in paperback. ~~$90.00~~

$47.95

BUILD YOUR OWN ELECTRIC MOTORCYCLE

by Carl Vogel. Published 2009.

Alternative fuel expert Carl Vogel gives you a hands-on guide with the latest technical information and easy-to-follow instructions for building a two-wheeled electric vehicle – from a streamlined scooter to a full-sized motorcycle. 384 pages in soft cover.

RADIO, TV AND HOBBIES April 1939 to March 1965

– Every article to enjoy once again on DVD-ROM!

This remarkable archival collection spans nearly three decades of Australia's own "Radio and Hobbies"/"Radio TV and Hobbies". Every article has been scanned into PDF format – ready to read at your leisure on your computer (obviously, a computer DVD-ROM reader is required along with Acrobat Reader 6 or later). For history buffs, it's worth its weight in gold. For vintage radio enthusiasts, what could be better? For anyone interested in electronics, this is one which you *MUST* have in your collection! **NB: Does not play on audio DVD players.**

$62

THE AMATEUR SCIENTIST CD

Brand new V4.

Many thousands of copies now sold. An incredible CD containing over 1000 classic projects, sourced from Scientific American over the past 73 years – covering every field of science. Very latest edition, just out. Suits ages 12 to adult and runs with any browser (on Win2000 or later). Recommended by the US National Science Teachers Assn.

$62

NOTE: ALL PRICES ARE PLUS P&P – AUSTRALIA ONLY: $10.00 per order; NZ – $12.00 PER BOOK; REST OF WORLD $18.00 PER BOOK

To Place Your Order:

eMAIL (24/7) silicon@siliconchip.com.au with order & credit card details

OR

FAX (24/7) Your order and card details to (02) 9939 2648 with all details

OR

PAYPAL (24/7) Use your PayPal account silicon@siliconchip.com.au

OR

PHONE - (9-5, Mon-Fri) Call (02) 9939 3295 with your credit card details

OR

MAIL Your order to PO Box 139 Collaroy NSW 2097

Or use the handy order form on P43 of this issue

*ALL TITLES SUBJECT TO AVAILABILITY. PRICES VALID FOR MONTH OF MAGAZINE ISSUE ONLY. ALL PRICES INCLUDE GST

ASK SILICON CHIP

Got a technical problem? Can't understand a piece of jargon or some technical principle? Drop us a line and we'll answer your question. Write to: Ask Silicon Chip, PO Box 139, Collaroy Beach, NSW 2097 or send an email to silicon@siliconchip.com.au

Questions on WIB project

I told a computer nut friend of mine about the WIB project and he wanted me to ask if it can support more than one website at a time, as well as whether it can do a shopping cart. I presume it can't do the shopping cart but that more than one website is possible if one has a URL pointed towards the IP of the unit plus specific pages mentioned. (L. B., via email).

● While multiple domain names may refer to the WIB's IP address, it will serve the same files on all domains. That does not mean that you cannot have multiple file hierarchies descended from the same root.

In relation to implementing a shopping cart, the WIB cannot support that, as it would require server side scripting, which the WIB does not provide.

Restoring defaults in the DSP Musicolour

I have built the DSP Musicolour (SILICON CHIP, June – September 2008). When the Musicolour is in idle mode, ie, waiting for an input signal, the four lamps are at full brightness. Which setting should I change so that the lamps are off until the music input signal is applied? (G. B., Fassifern, NSW).

● If you restore the default settings, the lights should be off when there is no audio input. The settings can be restored to their default values by using the menu system.

If the lights are not off with no audio input, that indicates a hardware problem. **If you need to check inside the case, the unit must be unplugged from the mains as much of the circuitry runs at 230VAC potential.**

Battery capacity meter for a boat

I am building the Battery Capacity Meter (SILICON CHIP, June & July 2009) to put in a boat to monitor the 12V 200Ah lead-acid "house" battery. The battery and the battery switch are in the bilge area but I would like to put the meter with the other electronics in the galley area.

Am I able to mount the current shunt near the battery switch and run three good-calibre leads (but not as big as the battery cable) from the shunt to the box? If so, what's the maximum recommended length depending on calibre of cable (I think I may need 5-6 metres)? I don't think I'll be using the relay circuit. (K. R., via email).

● Yes, you can mount the shunt at the battery and run three cables to the meter. The resistance of the wire to the BATT+ terminal should be kept to a minimum, so this wire should be as thick as possible.

Five to six metres of heavy duty wire should allow it to operate more or less normally.

If the resistance of this wire is too high and the load current is high, the measured battery voltage will not be as accurate. To avoid this, you can cut the track on the PC board between BATT+ and BATT HI (but not between BATT + and IC2) and run a fourth wire from the battery to BATT HI.

Note that we have not tested either approach, as the design assumes a short connection between the battery and the meter.

LCD malfunction on SD card audio player

I have built the Digital Audio Recorder/Player from the August 2009 issue, using a Jaycar kit. I have some questions.

Dimmers Do Affect Power Consumption

Recently I was drawn into a rather unpleasant argument on whether or not using light dimmers reduces power consumption for that lighting circuit. With my knowledge of how phase-controlled Triac dimmers work, I of course argued that dimmers do reduce power consumption.

Well, things went downhill from there, I was told I didn't know what I was talking about and was misinformed etc. I was also told he had sought advice from experts in the lighting industry, who informed him that dimmers do not reduce power consumption.

There are different types of dimmers and different types of lamps, which may be adding confusion to the argument. All this led me to wonder if I was missing something, hence the reason for this letter.

I am not looking for confirmation on my point of view, so I can say "I'm right and you're wrong!". It is because we are both involved in providing information to electricity consumers, on ways to reduce electricity consumption. There could be nothing worse than being misinformed, and passing that information onto others! (B. C., via email).

● Interesting question, B. C. The answer is that a light dimmer does reduce power consumption for the particular circuit but it does not reduce it by as much as you might expect. For example, if you reduce the light output to half, the power consumption may only be reduced by 30%.

The reason for this is that, as you dim an incandescent lamp, its colour temperature drops markedly and this rapidly reduces the useful light while producing proportionately more at the infrared end of the spectrum. When dimmed right down, the lamp produces virtually no light output but still produces considerable heat.

First, the three LEDs are not identified as to their purpose. Their function would be obvious if the recorder was working but mine isn't, yet! When the unit is switched on, the LCD lights up but only has 16 blocks on the top row where the characters should be.

All the voltages are within tolerance and I have checked out the circuit. I suspect that it's a software or firmware problem and I have probably reached my level of incompetence. Have you any suggestions? (A.B. Ashburton Vic).

● The fact that the LCD is showing 16 squares shows that it is not being initialised properly. You should make sure that the firmware is set to the correct version for the LCD you are using as the design can use two different LCDs, one from Jaycar and the other from Altronics.

You can press S4 and S8 together on start up to change the mode (to switch between the two LCDs). This may fix your problem. Otherwise, it may be that the LCD is not connected properly or that some lines are not connected properly to the microcontroller.

The LED functions are as follows: Green = play; Red = record; Yellow = remote control activity.

Cure for solar panels in shade

I had a 1kW solar voltaic system installed nine months ago. Unfortunately, I have now found out that the panels do not contain bypass diodes and so the slightest amount of shade on just one panel brings the entire power output down to nearly zero. The supplier plays "stupid" and I doubt that there is any help from his side, except suing him for "giving bad advice".

Obviously, no diodes can be retrofitted at cell level on the panels but I wonder if there are components or assemblies that can be retrofitted to bridge an entire panel? My panels have a nominal operating voltage of 36V and six of them are connected in series to provide nominally 216V.

If I had such devices I would only lose 36V, bringing the total voltage down to 180V which is still an improvement. Your advice and/or reference to a suitable solution would be very much appreciated. (K. F., Munster, WA).

● We think that, ideally, all cells in a panel should have reverse-biased Schottky diodes so the effects of partial shading can be minimised. In practice it appears that this is not done and as you have found, even complete panels do not have these diodes.

This is a serious drawback because if a leaf is blown onto a panel, that section will become reverse-biased while the rest of the panel (and indeed the whole array) continues to generate voltage. At the very least, it will cause the panel output to drop to zero. At worst, the now reverse-biased section of the panel may become a hot-spot and this could lead to eventual failure.

We would suggest that you connect a reverse-biased Schottky diode across each individual panel. A suitable Schottky diode would be the MBR20100CT twin diode available from Jaycar Electronics (Cat. ZB-1039). Each diode in the assembly has a rating of 10A.

Note that the two anodes should be connected together, to the negative terminal of the panel, while the common cathode is connected to the positive terminal of the panel.

Transformer Issue With Anti-Fouling Unit

I have just read the article on Ultrasonic Anti-fouling for Boats in the September 2010 issue and I believe that I have found an issue with the design of the transformer.

The design requires taking a piece of figure-8 wire, stripping one end and using this as the centre-tap point of the primary of the transformer. Once that is attached, the figure-8 cable is then wound around the former eight times and connected to the Mosfets. The idea is that the centre tap is connected to the supply rail and the Mosfets connect each winding to ground in turn.

The issue is that the transformer as described will not work very well. Each of the half primary windings will be energised in turn which is what should happen. However, since the two half windings are parallel, all that will happen is that the magnetic field in the transformer will be energised in a single direction before falling slightly in the dead time when both Mosfets are turned off. This will also have the impact of attempting to magnetise the core.

What should happen is that the primary winding should go in the one direction with the centre-tap in the centre. This will cause the maximum energy to be transferred to the secondary as the field will reverse during each half cycle.

I would also include a reverse-biased diode between the Drain and Source of Q1 and Q2 to conduct any residual field to ground during changes in field direction, further improving the efficiency of the design. (D. S., Ingleburn, NSW).

● Your assumption that "the design requires taking a piece of figure-8 wire, stripping one end and using this as the centre-tap point of the primary of the transformer" is not quite correct, as the two wires at one end of the figure-8 wire do not both connect to the +12V pin. At one end of the figure-8 wire, one wire goes to S1 (+12V) and the other wire goes to F1 at pin 12 for Q1's drain. The other ends of the figure-8 cable connect to F2 (+12V) and to S2 at Q2's drain.

If we start with the S1-F1 section of the winding (see Fig.3), the S1 end is at +12V. When Q1 switches on, current flows from S1 to F1 (anticlockwise when looking from the pin 1-6 end of T1). Using the righthand rule, the magnetic field is to the left (looking from the pin 7-13 end of T1 to the pin 1-6 end).

Then, for the F2-S2 winding, F2 is at +12V. When Q2 switches on, current flows from F2 to S2 (clockwise when looking from the pin 1-6 end of T1) and the magnetic field is to the right. So the field alternates.

With regard to your suggestion to include reverse-biased diodes across Q1 and Q2, this is not necessary since Mosfets include an intrinsic reverse diode between their Drain and Source terminals. For the RFP30N06LE Mosfets used for Q1 and Q2, the diode has a 125ns response and is therefore faster than a fast recovery diode such as the 1N4936 which has a 150ns response time.

32A charge controller wanted

I was looking for a Battery Charge

Substitute LEDs For The Stereo DAC Project

I am building the High-Quality Stereo DAC project and I need to know can I use switches with green LEDs instead of the ones with blue LEDs. Do I need to change the value of the three 2.2kΩ resistors?

Also, the data sheets for Toshiba TOSLINK receivers suggests a 47μH coil in series with the supply pin, as well as the 100nF capacitor across the supply. Is this unnecessary in your design or is it omitted because a different TOSLINK receiver is used? (J. W. London, UK).

● Yes you can use green or red LEDs for the front-panel buttons. You do not have to change the three 2.2kΩ resistors but you may wish to replace them with 3.3kΩ resistors since the green LEDs might be brighter; it depends on their exact characteristics.

Green LEDs have a lower forward voltage than blue ones (~2V instead of ~3V) so more current will flow but blue LEDs also tend to be more efficient so the effects may cancel out. The best thing to do is to use 2.2kΩ resistors initially and then change them if the LEDs are too bright.

As for the TOSLINK receivers, some brands do suggest using a 47μH inductor to filter the supply. However other (compatible) receivers do not require or mention an inductor. The datasheet we used when designing the DAC only showed a 100nF capacitor for bypassing, so that is what we used and that worked well with the Jaycar ZL3003 16mbps receivers. However, other receivers may need additional supply filtering so we have added the inductors to later designs on the basis that they can't hurt.

If you want to add an inductor to filter the power supply of your TOSLINK receivers then what you can do is install it in place of the pin header which allows for selection of the 3.3V or 5V supply for the TOSLINK receivers. A higher value inductor, say 100μH, will not hurt and will provide superior filtering. Just make sure you solder it to the correct supply rail to suit your receivers.

Controller to use with a 20V 32A supply. I came across a design in the April 2008 issue of SILICON CHIP but it only allows for 10A.

Can this be modified with higher capacity FETs or more heatsinking to accommodate my existing supply? (R. F., via email).

● The 12V battery charge controller from April 2008 was designed for up to 10A. For use at around 30A, the wiring arrangement would have to be different. The PC board is not suited for 30A and so the high-current connections would have to be off-board, including the connections to the Mosfet.

In addition, any connection points would need to use heavy-duty terminals rated for 30A. Wires then would need to be connected back to the PC board to complete the circuit.

These wires do not carry the heavy current. The Mosfet is rated for 30A although the device leads only have the standard TO-220 package cross-sectional area. You may do better with two IRF1405N Mosfets in parallel, with separate 10Ω gate drive resistors.

The fuse and holder would also need to be rated for 32A. Power dissipation by the Mosfets would be around 5W total.

Finally, a larger diecast box would also be needed to enclose the PC board and extra terminals and for heatsinking.

Solar panel confusion or what is a Watt?

I am currently working on a project involving solar-powered audio systems. In order to experiment with the required battery charging system, I purchased a 12V 5W solar battery charger panel from Altronics. It measures 465 x 320mm and produces a healthy 6.5W in strong sunlight.

My confusion relating to solar panels started when I went to the recent Perth Caravan and Camping Show and noticed many solar panels and battery charging systems on display. One display, consisting of four solar panels, captured my interest.

The panels, each measuring 440 x 540mm, were connected in parallel and charging a battery through a charge controller. A voltmeter and an ammeter were connected in line between the charge controller and the battery.

The voltmeter showed 12.5V and the ammeter showed 2A which, according to my calculations, produced up to 25W. Sunlight at the time was strong and the orientation of the panels looked reasonably correct.

After being informed by the attendant that the panels were rated at 20W each, I asked him why the panels were only producing 25W instead of 80W.

He informed me that power from solar panels is different to normal electricity and that the calculation, Volts x Amperes = Power in Watts was incorrect for solar panels. He stated that it was necessary to use a correction factor of 0.31 to calculate solar panel power.

Amazingly, his magic figure of 0.31 wherever it came from, seems to be correct: 80 Watts x 0.31 = 24.8 Watts, or 12.5V x 2A divided by 0.31 = 80.645 Watts.

Joking aside, the Altronics solar battery charger panel which produces ordinary electricity is completely satisfactory for my project. So do the 1kW and 1.5kW solar power systems, subsidised by the Government for home installations actually produce their rated power or 330W and 500W, respectively? (P. K., South Guildford, WA).

● It continues to amaze us just how much misinformation there is about solar panels.

A typical 12V-nominal solar panel actually produces its maximum power output at around 17V so if it is simply connected to charge a 12V battery it can never produce its maximum output and it will over-charge the battery in the process.

The only way the panel can produce its optimum output is for it to be connected to the load via a "maximum power point tracker" (MPPT) which is essentially a step-down DC-DC converter. We published a solar-powered lighting system featuring MPPT in the May 2010 issue.

As far as typical grid-feed solar systems are concerned, they rarely seem to produce their rated output, even when the Sun's rays are perpendicular to the panel. Partly, this is because of losses in the DC-AC inverter but it may just be that such inverters do not include MPPT, although it would be fair to expect that this feature would be mandatory.

We would welcome comments from

readers who have had grid-feed solar systems installed.

Simple train controller with reversing feature

Jaycar at Caringbah sold me a KC5225 kit to control a 12V motor for a model locomotive. The kit has a fixed trimpot. How can I control the speed of the loco? Can I fit a variable separate trimpot and wire it into the PC board?

I also wish to have a reversing facility which could be a double-pole switch to the rails. Do I have the right kit? Is there another solution to the problem? (G. O., via email).

● That kit is a high-current motor speed controller and is not suitable as a controller for model railways. If you want a simple controller with forward/reverse and preset start voltage etc, have a look at the Train Controller featured in the April 1997 issue of SILICON CHIP. This uses simple parts and although no kit is available, you can still purchase the PC board from RCS radio at **www.rcsradio.com.au**

You will need to see the article which we can supply for $12.00 including GST and P&P (Australia).

Galena crystals for a genuine crystal set

I would like to make a genuine old-fashioned crystal set for my bright 8-year old grandson; a genuine one with a galena crystal held in place with an alligator clip and pricked with a bit of fuse wire.

I don't want to use a diode although I have seen a circuit, on the internet, which uses a diode. This ensures that the signal is coming through and then allows a switching to the crystal.

Where do I get a crystal of galena? How important is it to have the right old-fashioned earphones (2000Ω?)? (J. R., West Pymble, NSW).

● For galena crystals, try **http://www.midnightscience.com/catalog5.html**

You do need high-impedance phones and one way to get around this problem is to use any low impedance headphones or earphones stepped up by a miniature 1kΩ:8Ω output transformer such as Jaycar MM-2532. In fact, this combination should be appreciably more sensitive than the old-style 2000Ω phones.

Microwave oven transformers

Is there any reason that I shouldn't use a microwave oven transformer backwards? I have bench-tested a few after detaching the wire from the laminated core and hooking what was originally the secondary winding up to the mains. The results were about 22-26V AC at 6A or 7A across what was originally the primary winding. The single insulated winding was removed.

Do these transformers have a special core or something else that makes it unwise to use them in this fashion? (R. B., Dereel, Vic).

● As you have noted, microwave oven transformers have one end of their secondary winding connected to the transformer core. Removing the connection does not necessarily ensure the transformer complies with Australian Standard AS 3108. This standard applies to isolation transformers and requires that 3kV AC RMS can be applied without breakdown between primary and secondaries and between the primary and frame and between the secondary and frame.

For safety, be certain that the primary and secondary windings are correctly isolated and that the secondary winding is isolated, insulated and protected from making contact with the frame.

In addition, the secondary winding in a microwave transformer is designed for high voltage at around 20kV. When used in reverse with 230VAC applied instead to this high voltage winding, the transformer will not deliver its rated power at the secondary.

So while we would expect a microwave transformer to deliver at least 1kVA and substantially more in the case of a bigger oven, your reverse

. . . continued on page 111

Notes & Errata

High-Performance Microphone Preamplifier, September 2010: CON3 on the circuit diagram (Fig.3) is shown with its tip and ring connections swapped.

Christmas Lights Controller, October 2010: the following parts should be added to the master module parts list: 1 28-pin DIP socket, 2 M3 x 6mm machine screws, 2 M3 shakeproof washers, 2 M3 nuts, 1 mini TO-220 heatsink (Jaycar HH8502, Altronics H0630).

DAB+/FM Stereo Tuner, October 2010: the collector and emitter labels for PNP transistor Q2 are shown transposed on the circuit diagram (Fig.1). In addition, the 100nF capacitors connected to pins 3 & 5 of IC4 should both be 220nF. The parts layout diagram (Fig.3) in Pt.2 is correct.

WARNING!

SILICON CHIP magazine regularly describes projects which employ a mains power supply or produce high voltage. All such projects should be considered dangerous or even lethal if not used safely.

Readers are warned that high voltage wiring should be carried out according to the instructions in the articles. When working on these projects use extreme care to ensure that you do not accidentally come into contact with mains AC voltages or high voltage DC. If you are not confident about working with projects employing mains voltages or other high voltages, you are advised not to attempt work on them. Silicon Chip Publications Pty Ltd disclaims any liability for damages should anyone be killed or injured while working on a project or circuit described in any issue of SILICON CHIP magazine.

Devices or circuits described in SILICON CHIP may be covered by patents. SILICON CHIP disclaims any liability for the infringement of such patents by the manufacturing or selling of any such equipment. SILICON CHIP also disclaims any liability for projects which are used in such a way as to infringe relevant government regulations and by-laws.

Advertisers are warned that they are responsible for the content of all advertisements and that they must conform to the Trade Practices Act 1974 or as subsequently amended and to any governmental regulations which are applicable.

MARKET CENTRE

Cash in your surplus gear. Advertise it here in SILICON CHIP

ELNEC IC PROGRAMMERS

High quality
Realistic prices
Free software updates
Large range of adaptors
Windows 95/98/Me/NT/2k/XP

CLEVERSCOPE USB OSCILLOSCOPES

2 x 100MSa/s 10bit inputs + trigger
100MHz bandwidth
8 x digital inputs
4M samples/input
Sig-gen + spectrum analyser
Windows 98/Me/NT/2k/XP

IMAGECRAFT C COMPILERS

ANSI C compilers, Windows IDE
AVR, TMS430, ARM7/ARM9
68HC08, 68HC11, 68HC12

GRANTRONICS PTY LTD
www.grantronics.com.au

SPLat CONTROLS **Tough times demand innovative solutions!**

In tough economic times you need to watch every dollar. SPLat embedded controllers give OEMs more functionality per dollar than any competing product. Check out our website today and discover how we can help you remain competitive.

Made in Australia, used by OEMs world-wide

splat-sc.com

Battery Packs & Chargers

Siomar Battery Engineering
www.batterybook.com
Phone (08) 9302 5444

WOW! A QUALITY DSP HF COMMUNICATIONS RECEIVER FOR 10% OFF?

Yes, it's true! Don't let its tiny size fool you. This powerhouse receiver covers the AM, FM, LW and entire SW bands from 3.5 to 30MHz – and has genuine Digital Signal Processing!

Exclusive to Avcomm, the Tecsun PL-310 DSP normally sells for $90.00 (plus p&h) but if you say you saw it in SILICON CHIP, Avcomm will give you an amazing 10% off!

Hurry – stocks are limited. Call Avcomm now – (02) 9939 4377

For more details visit www.avcomm.com.au

Australian Valve Audio Transformers

Output Transformers
Power Transformers

WEB: WWW.AVAT.COM.AU
Ph: 03 94516863

FOR SALE

LEDs! Nichia, Cree and other brand name LEDs at excellent prices. LED drivers, including ultra-reliable linear driver options. Many other interesting and hard-to-find electronic items! **www.ledsales.com.au**

terrystransistors.com.au: genuine MJE15030/31 BD139/40 2SA970 BF469/470 MJE340/50 MJL4302A MJL4281A **ON@$9.20** MJL21193/4 MJL1302A MJL3281A 2SA1085 MPSA42 Cheap postage.

questronix.com.au – audiovisual experts solve home, corporate security and devotional installation & editing woes. QuestAV CYP, Kramer TVone (02) 4343 1970 or **sales@questronix.com.au**

PCBs MADE, ONE OR MANY. Any format, hobbyists welcome. Sesame Electronics Phone (02) 9593 1025. **sesame@sesame.com.au** **www.sesame.com.au**

KINSTEN: Make your own PCBs. Presensitised PCBs, chemicals, tools and Kynar wire. Phone 08 6465 9799 or order at **www.kinsten.com.au**

HMI and PLC in One! Comfile Technologies CuTouch (CT1721-C). Also available in Black and White screen for viewing outdoors. The CuTOUCH comes integrated with industrial controller, Blue & White Graphic LCD, touch-input processor, opto-isolated I/O boards, analog inputs & outputs, and Plug-n-Play support for Relay boards. 64 I/O plus 6 channels PWM or DAC, 4 external interrupts, and 2 16-bit counters.

The CuTOUCH units can be programmed in BASIC or Relay Ladder Logic using the Cubloc Studio Software available from our website. Applications can range anywhere from home automation to industrial gas monitoring. By providing easy-to-use GUI tools, Comfile Technology guarantees you a competitive edge over any other touch screen products on the market today. Replace outdated PLC, push-buttons, small LCD combo with 1 single CuTOUCH™.

Many other Windows CE & XP PLCs, core modules and accessories. Call for info: **sales@ozcomfile.com.au** or 1300 208 570. **www.ozcomfile.com.au**

RCS RADIO/DESIGN is at 41 Arlewis St, Chester Hill 2162, NSW Australia and has all the published PC boards

Advertising rates for these pages: Classified ads: $29.50 (incl. GST) for up to 20 words plus 85 cents for each additional word. Display ads: $54.50 (incl. GST) per column centimetre (max. 10cm). Closing date: 5 weeks prior to month of sale. To book, email the text to **silicon@siliconchip.com.au** and include your name, address & credit card details, or fax (02) 9939 2648, or phone (02) 9939 3295.

537 Kits, Modules and Boxes

Innovative & affordable projects for hobby, school & industry

FK144
4 Channel 8 Programme 25 Watt Light Chaser
(buy as a kit or preassembled)

Shop on-line at:
www.kitstop.com.au
electronics-the fun starts here

34 CHAN 500MHZ LOGIC ANALYSER
INTRONIX

* RS232, I²C, SPI, CAN Interpreters
* USB powered
* Data compression
* +/- 6 Volt threshold
* Advanced multi level triggering
* Ideal for microprocessor debugging

XELTEK
SuperPro Device Programmers
Fastest low cost programmers! Standalone & USB. Socket adapters.

02 4567 8999
DIGITAL GRAPHICS
www.digitalgraphics.com.au

Printed Circuit Board Manufacture
48-Hour service * High quality * Low prices
1 offs to any quantity
Artwork design if required
Call for obligation free quote...
INSTANT PCBs, PO Box 448, Avalon 2107
Ph (02)9974 1189 Fax (02)9974 5491

from SC, EA, ETI, HE, AEM & others. Ph (02) 9738 0330. **sales@rcsradio.com.au; www.rcsradio.com.au**

WANTED

CUSTOMERS WANTED: Truscotts Electronic World – large range of semiconductors and passive components for industry, hobbyist and amateur projects including Drew Diamond. 27 The Mall, South Croydon, Melbourne. Phone (03) 9723 3860. **sales@electronicworld.com.au**

WANTED: EARLY HIFIs, AMPLIFIERS, Speakers, Turntables, Valves, Books, Quad, Leak, Pye, Lowther, Ortofon, SME, Western Electric, Altec, Marantz, McIntosh, Tannoy, Goodmans, Wharfedale, radio and wireless. Collector/Hobbyist will pay cash. (07) 5471 1062. **johnmurt@highprofile.com.au**

KIT ASSEMBLY

KEITH RIPPON KIT ASSEMBLY & REPAIR:
* Australia & New Zealand;
* Small production runs.
Phone Keith 0409 662 794.
keith.rippon@gmail.com

connection is delivering less than 160VA.

Ideally, for full utilisation of the transformer core, the transformer should be rewound. Details about doing this are at **http://www.users.on.net/~endsodds/psrewind.htm**

Using the Zapper on 8V batteries

Regarding the two projects, Battery checker and Battery Zapper, in your July and August 2009 issues, I wish to use both projects on golf-cart batteries which are 205-225Ah, 6V & 8V types.

I presume there would be no problem with the 6V units but do I need to modify either circuit for the 8V batteries (eg, shift the 12V leg on switch S3a in the Checker for 8V)? Also, is there any problem using a 12V charger with both voltages in the Zapper circuit?

I was also wondering if I can up rate the current pulses to around 100A for a really solid test on golf-cart batteries. I had considered that by adding to the D6-D7 configuration and utilising a fourth position on the Amp setting switch, this would be possible. What do you think? (J. N., via email).

● There shouldn't be any problem using the Zapper with 8V batteries, if you leave voltage switch S1 in the 6-12V position. However we would be cautious about using a 12V charger with the Zapper for either 6V or 8V batteries, unless it has inbuilt current limiting and is specified as being suitable for 6-8V batteries.

When it comes to the Battery Checker, we suggest that you do in effect convert the "12V" range of S3a into an 8V range so that the Checker gives more sensible readings for 8V batteries. To do this without significantly changing the operation with 6V or 24V batteries, we suggest these changes:

(1) Replace the 220Ω resistor between the "12V" and "24V" positions of S3a with a 470Ω resistor.

(2) Replace both of the series 220Ω resistors between the "6V" and "12V" positions of switch S3a with a single 200Ω resistor.

(3) Re-label the centre position of S3 as "8V", instead of "12V".

It is also feasible to increase the test current for the Battery Checker. The easiest way would be to replace the 4 x 0.22Ω 5W resistors with 4 x 0.1Ω 5W resistors and run one or more strands of 0.71mm tinned copper wire (or if your board has a solder mask, insulated copper wires) on top of the copper traces that run from the drains of the Mosfet pairs to the cathode of each 6A1 diode (D8 & D9). This will change the current settings to 26A, 55A and 88A.

The components can handle the extra current as it is pulsed but the wire connecting the battery to the checker should be thicker to minimise the voltage drop and you will need to be very careful about making a good connection to the binding posts.

Having said that, we are not sure that you will necessarily get accurate results under these conditions. Our tests at the 12A, 25A and 40A settings show that it gives a good indication of condition with common types of lead-acid batteries. We do not know for sure whether the readings at the higher current level (88A) will be similarly indicative.

Because of the higher current drain, the battery voltage will drop further than expected and this will likely require re-calibration of the condition meter. Attach a freshly charged battery, known to be in good condition, to the tester and check it. If the reading is lower than expected, try reducing the value of the 15kΩ resistor at pin 4 of IC5 to, say, 12kΩ or perhaps 10kΩ.

You may also need to insert a small value resistor (1-3kΩ) between pin 6 of IC5 and the associated 10μF capacitor to allow the "Good" LED to light at all due to the higher voltage drop.

Finally, you may find that golf-cart batteries have a higher internal resistance than typical lead-acid batteries and if so, that will also increase the voltage drop under load and thus contribute to the need to adjust the sensitivity. SC

Do you eat, breathe and sleep TECHNOLOGY?

Opportunities exist for experienced Sales Professionals & Store Management across Australia & NZ

Jaycar Electronics is a rapidly growing, Australian owned, international retailer with more than 60 stores in Australia and New Zealand. Due to our aggressive expansion program we are seeking dedicated sales professionals to join our retail team to assist us in achieving our goals. We pride ourselves on technical expertise from our staff. Do you think that the following statements describe you? Please put a tick in the boxes that do:

- ☐ Knowledge of core electronics, particularly at a component level
- ☐ Retail experience, highly regarded
- ☐ Assemble projects or kits yourself for your car, computer, audio etc
- ☐ Have energy, enthusiasm and a personality that enjoys helping people
- ☐ Opportunities for future advancement and development
- ☐ Why not do something you love and get paid for it?

Please email us your applicaton & CV in PDF format, including location preference. We offer a competitive salary, sales incentive and have a generous staff purchase policy. Applications should be emailed to

jobs@jaycar.com.au

Jaycar Electronics

Jaycar Electronics is an Equal Opportunity Employer. & actively promotes staff from within the organisation.

RFMA RF Modules Australia

Low Power Wireless Connectivity Specialists

KFX2-433 Keyfob

Code Hopping Transmitter

In Stock NOW!

Range: 100m

Power: 5mW

1 to 5 Buttons

LED Indication of Transmit

Applications:

Rural

Utilities

Industrial

Commercial

Government

Security Systems

KDEC-433 Relay

Relay Output Receiver

In Stock NOW!

LED Indicators

5 Relay NO/NC

Low battery indicator

Learns upto 16 Keyfobs

RADIOMETRIX: Low Power, Licence Exempt Radio Modules

RF Modules Australia. P.O. Box 1957 Launceston, TAS., 7250.
Ph: 03-6331-6789. Email: sales@rfmodules.com.au. Web: rfmodules.com.au

into RF?

There's something to suit every radio frequency fan in the SILICON CHIP reference bookshop

RF Circuit Design
– by Chris Bowick
A new edition of this classic RF design text - tells how to design and integrate RF components into virtually any circuitry. **$74**

Practical RF H'book
– by Ian Hickman
A reference work for technicians, engineers, students and the more specialised enthusiast. Covers all the key topics in RF that you need to understand **$73**

Practical Guide To Satellite TV
– by Garry Cratt
The reference written by an Aussie for Aussie conditions.Everything you need to know. **$49**

You'll find many more technical titles in the SILICON CHIP reference bookshop – see elsewhere in this issue

DOWNLOAD OUR CATALOG AT
www.iinet.net.au/~worcom

WORLDWIDE ELECTRONIC COMPONENTS
PO Box 631, Hillarys, WA 6923
Ph: (08) 9307 7305 Fax: (08) 9307 7309
Email: worcom@iinet.net.au

Silicon Chip

Circuit Ideas Wanted

Do you have a good circuit idea? If so, sketch it out, write a brief description of its operation & send it to us.

Provided your idea is workable & original, we'll publish it in Circuit Notebook & you'll make some money. We pay up to $100 for a good circuit idea or you could win some test gear.

Silicon Chip Publications, PO Box 139, Collaroy, NSW 2097.

Advertising Index

Altronics ..... loose insert
Amateur Scientist CD 3
Australian Valve Audio 110
Av-Comm 110
Cleverscope 40
Dick Smith Electronics 18-19
Digital Graphics 111
Dyne Industries 10
Emona Instruments 39
Front Panel Express 5
H. K. Wentworth 42
Grantronics 110
Hare & Forbes ..... OBC
High Profile Communications 111
Instant PCBs 111
Jaycar IFC,49-64,112
Keith Rippon 111
Kinsten Pty Ltd 110
Kitstop 111
LED Sales 110
Oatley Electronics ..... IBC
Ocean Controls 6
OzComfile 110
PCBCART 5
ProtoGear 8
Quest Electronics 110
RCS Radio 110
RF Modules 112
Sesame Electronics 110
Silicon Chip Binders 65
Silicon Chip Bookshop 104-105
Silicon Chip Order Form 43
Siomar Battery Engineering 7,110
Soundlabs Group 8
Splat Controls 110
Temwell Corporation 69
Tenrod 9
Terry's Transistors 110
Truscotts Electronic World 111
Wagner Electronics 41
Wiltronics 11
Worldwide Elect. Components 112

PC Boards

Printed circuit boards for SILICON CHIP designs can be obtained from RCS Radio Pty Ltd. Phone (02) 9738 0330. Fax (02) 9738 0331.

OATLEY ELECTRONICS

www.oatleyelectronics.com

USED 15" TOUCH-SCREEN LCD MONITORS

These monitors were removed from commercial point of sale computers and fully tested before shipping. Could be enclosed and used with hobby CNC or workshop uses where dust etc. is a problem. They are just an outer case with mounting brackets. They use a Elo Touchsystems - IntelliTouch FLT15.1-007-004-F touch panel over the LCD. They will run with Windows XP at 1024x768 Resolution. The drivers for the touch pannel are available on the net for XP and other operating systems (link provided on our web-site). The LCD plugs into your PCs VGA port and serial port We have not tested them with Windows Vista or 7. Included with each LCD is the LCD, Touch panel + approx 1Meter Power VGA and Serial cables + Power supply unit with IEC plug out x2 and additional +5v+12v +24v rails + screen control pad.

LIMITED STOCK DON'T MISS OUT!! [TSLCD]

CD QUALITY DIGITAL AUDIO BROADCAST (DAB+) + HD DIGITAL TV + FM STEREO 3 IN 1

This amazing device not only receives HD digital TV (DVB-T) and FM stereo radio but digital radio (DAB+). It has a Belling-Lee connecter ready for use with a rabit-ear or other TV antenna. Comes complete with USB receiver, IR remote control and software CD. See our website for computer requirements & more.

K239 - VIRTUALLY PRE-BUILT CODE HOPPING 4 CHANNEL REMOTE CONTROL

This kit is almost identical in its function to our K180 but is pre-built (requires soldering of 2 wires). Has individual limit/reset input for each channel. Combined with our TX8 Transmitter (not incl.), this kit can control any combination of four output relays in either momentary or latching operation. Features inc. range of ~50m, indicator LEDs, & screw terminals for ease of use. [K239]$30.00

SPARE TRANSMITTER TO SUIT K239

This small key fob transmitter is used in conjunction with the K239. Uses a pre-built and pre-aligned 433MHz UHF code hopping transmitter module. Includes transmitter module, battery clips, battery and key-fob case. [TX8] $15.00

TX9 4CH CODE HOPPING UHF TRANSMITTER

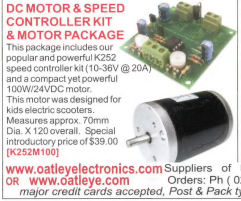
Small KEYFOB 433MHz SAW resonator locked, microprocessor code encoding 4 channel transmitter. Gives over 200M range, even with some obstructions in the path, with the sensitive RX9 receiver. The range can be increased to around 1.5KM by adding our TX01 transmitter module.

[TX9] $16.00

RX9 CODE HOPPING RECEIVER MODULE

Sensitive (-115dbM) dual conversion SAW RESONATOR LOCKED, superhetrodyne 433MHz UHF receiver module with micro-processor code hopping decoding. Four outputs (D0-D3) go high when the corresponding transmitter button (TA-TD) or a combination of buttons is/are pressed (as a result it can be used to transmit parallel data), and the VT output goes high when any of the transmitter buttons are pressed. Can learn over 100 transmitters. The learning push button and an indicator LED are included on the small PCB. PCB dimensions are 38 x 24mm, 5V/13mA operation. Gives over 200M range, even with some obstructions in the path, when used with our TX9. [RX9] $19.00

ELECTRIC BIKE KITS! - LARGE DC MOTORS (GEARED & DIRECT DRIVE) - SPEED CONTROLLERS - WHEELS - THROTTLES - SPROCKETS AND CHAINS - SEE OUR WEB



DC MOTOR & SPEED CONTROLLER KIT & MOTOR PACKAGE

This package includes our popular and powerful K252 speed controller kit (10-36V @ 20A) and a compact yet powerful 100W/24VDC motor. This motor was designed for kids electric scooters. Measures approx. 70mm Dia. X 120 overall. Special introductory price of $39.00 **[K252M100]**

LCD DIGITAL THERMOMETER

"Inside" & "outside" temperatures, Features includes clock function display Outside sensor on 1.5M cable. [1TEMP] $11.00

INTELLIGENT 12V BATTERY CHARGER

This is one of our most popular kits. It automatically charges 12V batteries at 0.8A. Kit comes with 9V/2.2A power adaptor as shown. Switches of at float then resumes charging when the battery voltage falls by 0.5V: This charger can be left connected undefinedly to batteries to keep them in good condition. Ideal for use with vehicle batteries that are not used very often like Tractors, Boats, batteries etc. **[K215]**: $20 for the kit plus the plugpack.

HIGH POWER - 0.5W / 150mA / 10mm WHITE LED

25 Lumens @ 150mA/ 80,000 mcd @ 20mA. Vf min @ 20mA= 3.0 Vf max @ 20mA = 3.6 No additional heatsinking needed. Water clear lens. **[L10W] $2.40**

www.oatleyelectronics.com OR www.oatley.com Suppliers of kits and surplus electronics to hobbyists, experimenters, industry & professionals. Orders: Ph (02) 9584 3563, Fax 9584 3561, sales@oatleyelectronics.com, PO Box 89 Oatley NSW 2223

major credit cards accepted, Post & Pack typically $7 Prices subject to change without notice ACN 068 740 081 ABN18068 740 081

3 Day annual SALE

THURSDAY 11TH - SATURDAY 13TH NOVEMBER 2010

ENDS 4.00PM SAT **HUGE SAVINGS ONLINE OR IN STORE**

DRILLING MACHINE

- 1hp 240V motor
- 16-speed • 2MT
- 16mm drill capacity
- Includes 16mm drill chuck & arbor

HOT PRICE

Bench Model
$253 (D138)

BS-4A BAND SAW

- 150 x 100mm capacity
- 3 speed
- 1/2hp 240V motor
- Vertical table

$297 (B002)

MAGNETIC BASE & METRIC DIAL INDICATOR

- 0-10mm dial travel

$55 (M099)

PUNCH SETS

3/16" Letter	**$33.00** (P350)
3/16" Number	**$16.50** (P351)
5/16" Letter	**$44.00** (P354)
5/16" Number	**$19.80** (P355)

KEYWAY BROACH SETS

- Supplied in wooden case
- High-speed steel broach set consisting of broaches, brushes and packing shims

Metric Set	Imperial Set
$418 (M498)	**$418** (M500)

WORK LAMP / LIGHT

35Watt - Magnetic base flexible arm
$110 (L263)

55Watt - 3 pivot arm 800mm long
$119.90 (L285)

22Watt - Fluorescent with 5X Magnify
$132 (L282)

PRECISION MACHINE VICES

SIZE	OPEN	
100mm	82mm	**$137.50** (V104)
125mm	85mm	**$192.50** (V105)
150mm	114mm	**$209.00** (V106)
200mm	150mm	**$363.00** (V108)

SAND BLAST CABINET

- Includes: work light, ceramic nozzles, gun & gloves

HOT PRICE

Internal Size approx: 590 x 500 x 300-360mm
$154 (S288)

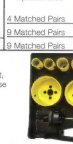
3 WAY ANGLE MILL VICES

SIZE	OPEN	
75mm	82mm	**$275** (V113)
125mm	95mm	**$297** (V115)

PARALLEL SETS

Precision ground to 0.0003" tolerance

- (M250 & M252) 150mm long
- (M253) Both 100 & 150mm long in a plastic case



4 Matched Pairs	**$82.50** (M250)
9 Matched Pairs	**$165.00** (M252)
9 Matched Pairs	**$264.00** (M253)

HAND SHEARS

Capacity	Blade Length	
5mm	160mm	**$154** (S189)
6mm	200mm	**$264** (S191)
8mm	300mm	**$363** (S193)
8mm	200mm	**$583** (S195)

3 IN 1 SHEET METAL MACHINE

Bender
Rolls
Guillotine

200 x 1mm	**$253** (S049)
300 x 1mm	**$352** (S648)
760 x 1mm	**$572** (S650)
1000 x 1mm	**$979** (S652)
1320 x 1.2mm	**$1,969** (S653)

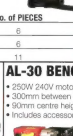
VICE PRESSBRAKE - Bender

- Ingenious sheet metal bender
- Bends up to 2mm thick mild steel
- Strong magnets hold die & knife to vice jaws
- Segmented knife

SIZE	
100mm	**$38.50** (V050)
125mm	**$49.50** (V051)
150mm	**$60.50** (V052)

HOLE SAW SETS

- Bi-Metal high speed steel hole saw set, supplied in convenient blow mould case
- Includes 3/8" & 1/2" shank arbors
- Pilot drill & spring



TYPE	RANGE	No. of PIECES	
Plumbers	19 - 57mm	6	**$38.50** (D103)
Electricians	22 - 64mm	6	**$38.50** (D104)
General	19 - 76mm	11	**$66.00** (D102)

COUNTERSINK SET

- 4 piece set cross hole type
- Range: 2-5, 5-10, 10-15, 15-20mm

Metric
6-20mm
$55 (D100)

TAP WRENCHES

- Adjustable tap wrench
- Hardened Jaws
- Forged steel

SIZE		
No.1 M1-M10	**$8.80**	(T953)
5/32" - 3/8"	**$16.50**	(T010)
No.4 M10-M27	**$22.00**	(T956)

RATCHET TAP WRENCHES

- Forward/reverse operation & lock
- Designed for use with taps reamers screw extractors & other tools with a square shank

SIZE		
No.1 M3-M10	**$12.65**	(T960)
No.2 M5-M12	**$16.50**	(T961)

X3 MILL DRILL

- Dovetail vertical slide
- Variable speed (100-2000rpm) 2-speed gearbox
- 3MT spindle
- 80mm face mill cap.
- 25mm mill & drill cap.
- 600W 240V motor
- 650 x 160mm table size

STAND **$297** (M153)

$1,639 (M153)

AL-30 BENCH LATHE

- 250W 240V motor
- 300mm between centers
- 90mm centre height
- Includes accessories

Tool Set Included

$759 (L194)

COUNTERSINK SET

- 3 Flute type

6 piece set
$55 (D106)

DEBURRING TOOL Sheet metal Burr

- Sheet metal burr, hand guard & 2 x Ø11.7mm blades
- Simultaneously removes burrs from both sides of sheet metal
- Range 0-7.5mm

$22 (D063)

TAP & DRILL SET 29 Piece - Metric HSS Set

- 3, 4, 5, 6, 8, 10 & 12mm Taps (3 taps per size)
- Includes drill to suit each size tap

$63.80 (T019)

DIGITAL SCALE With display unit

- ON/OFF in any position
- Remembers the last setting
- Metric/Imperial switch
- Mini USB connection to the display unit

620mm	900mm
$66 (D665)	**$88** (D667)

DIGITAL CALIPERS - Platinum Edition

- Large display
- Hard and stainless steel mechanism

	WAS	NOW	
0-150mm	**$120**	**$77**	(30-700)
0-200mm	**$164**	**$99**	(30-701)

Sydney (02) 9890 9111
Unit 1/2 Windsor Rd
Northmead NSW

Brisbane (07) 3274 4222
626 Boundary Rd,
Coopers Plains QLD

Melbourne (03) 9212 4422
1 Fowler Rd,
Dandenong VIC

Perth (08) 9373 9999
22 Brennan Way,
Belmont WA

www.machineryhouse.com.au

Specifications & Prices are subject to change without notification. All prices include G.S.T. and valid until 13-11-10 (*WA prices may be higher due to freight costs)

100% Australian Owned Est. 1930

HARE & FORBES MACHINERY HOUSE